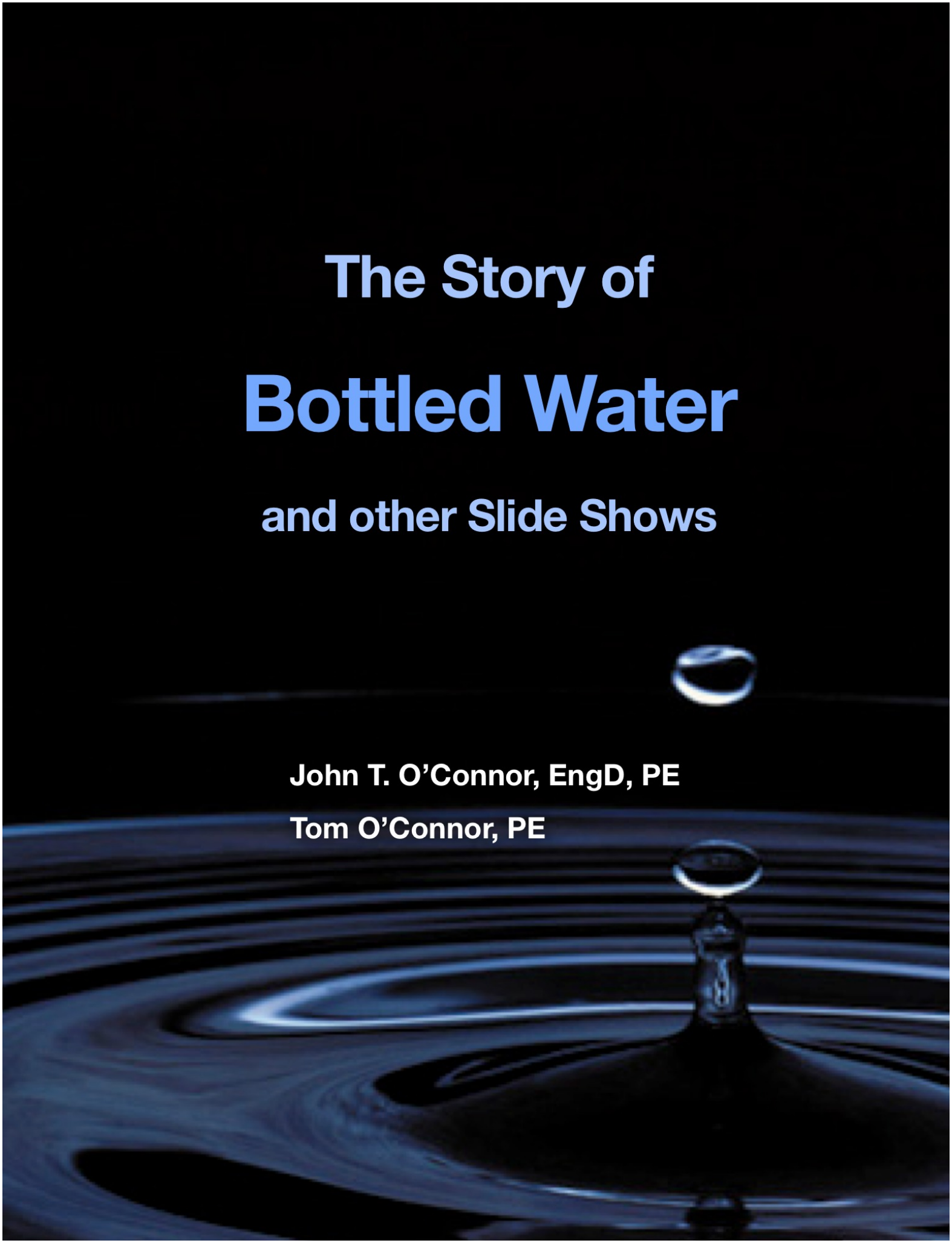
The Story of

Bottled Water

and other Slide Shows



John T. O'Connor, EngD, PE

Tom O'Connor, PE

COLUMBIA MISSOURIAN

Local collector puts bottled water to the test

By Brendan Gibbons
March 26, 2013 | 6:00 a.m. CDT

John O'Connor holds a microscope in the basement laboratory of his Columbia home. A retired MU professor and former chairman of the Civil Engineering Department, O'Connor has been comparing bottled water to ground water since 1980. Currently he runs a water consultancy company, and many of his clients are municipal water providers. ¦ Elizabeth Cardwell

COLUMBIA — John O'Connor flicked on the lights in his cluttered basement, illuminating an array of expensive microscopes, chemicals and water testing equipment.

“A lot of the equipment I have here is what you would see at a municipal water treatment plant laboratory,” O'Connor said.

More Story

O'Connor, 80, runs his water quality consulting firm, H2O'C Engineering, from his house on Tahoe Court, along with his son,

Related Media

Retired MU professor John O'Connor has been collecting and studying bottled water since the early 1980s. O'Connor's extensive water bottle collection is currently on display at the University of California-Davis.

Tom. He formerly served as chairman of MU's Civil Engineering Department and chief of the Illinois State Water Survey.

Starting in the 1980s, O'Connor began collecting and testing bottled water. He ended up compiling a huge collection, complete with water quality data from his tests. He estimated that at its peak, the collection contained between 200 and 300 bottles. Some of the collection is now on display at the University of California at Davis.

In 2008, bottled water surpassed soda as the most popular drink in the U.S., according to an Associated Press story published March 11. The plastic used to make water bottles is a petroleum byproduct, and about 17 million barrels of oil per year is required to meet demands for bottled water in the U.S., according to Earth Policy Institute.

O'Connor started his water collection as a side project. Around 1980, Monsanto Corp. awarded O'Connor a grant to buy water testing equipment he could use it to measure total organic carbon in treated drinking water.

The amount of organic carbon present in a water sample indicates how much broken-down material from dead plants, dead animals or feces has made its way into a water supply.

“Water treatment processes are not very effective at removing this type of material,” O'Connor said. “To the extent that you can find a water source that has a minimal amount of total organic carbon, you're better off.”

O'Connor could also estimate the number of bacterial cells present in a water sample by using a fluorescent dye to mark the cells, then counting them under a microscope.

Bacterial cell count and total organic carbon became the bases O'Connor used to judge the quality of a water sample.

“Although they weren't regulated, these were two critical parameters in judging how good a water really was,” he said.

One of O'Connor's first studies using his new equipment was a test of more than 100 drinking water samples from across Missouri. In the mid-1980s, he began to turn his attention to bottled water.

“We just had the equipment, and like kids with new toys, we were going to apply it to whatever we

could get our hands on," he said.

O'Connor wanted to see if the water in the bottle measured up to the label. "The claims were getting extravagant, that is, bottled waters were safer and purer than tap water," he said. "Sometimes it was, and sometimes it wasn't."

Word began to get around that he was doing these tests, and soon friends and colleagues started bringing O'Connor and his students bottled water from around the world for them to test.

His collection started to grow. He began making a slide show of bottled water from different decades and from around the world. As he fact-checked the claims on the bottles, he wasn't afraid to mock the companies' marketing ploys.

In his slide show, he calls Perrier's green, bowling-pin-shaped bottle a "fashion accessory for yuppies."

A bottle of Canadian Essence Natural Spring Water displays a pristine lake on its label, complete with a duck and a snowy forest. In response, O'Connor jokingly offered this train of false logic: "Cold water tastes good! It's cold in Canada! Canadian water tastes good!"

His tests showed the truth. "No lake here," he wrote. "The data indicate a moderately hard groundwater."

He mentioned Mountain Valley Spring Water, bottled in Arkansas, as an example of quality bottled water.

"It's very much like many of the Missouri well waters from the southern part of the state," he said. "It's basically rain water infiltration, and it's stored in aquifers that are basically limestone."

Most bottled water is no better than the water you get from your tap, O'Connor said. His slide show spells it out: "Despite advertising illusions, most of the water sold in the U.S. is groundwater; 25 percent is derived from municipal water sources."

No bottled water can compete with the water that comes out of an MU drinking fountain, O'Connor said. Some of the highest quality water O'Connor has ever tested lies more than 1,000 feet below Columbia.

"It is far superior to most potable waters," he said.

O'Connor said he used MU's drinking water as a reference because it has the lowest level of organic carbon and bacterial cell count of any water he's ever measured.

O'Connor posted the results of his bottled water project on his blog. A few years ago, it got the attention of Allen Doyle, sustainability manager for the University of California at Davis.

“I saw John's slide show on the American Chemical Society's website and was tickled with its mix of irony and facts, and the breadth of issues,” Doyle said in an email.

Doyle emailed O'Connor to thank him, and the two struck up a correspondence. When O'Connor mentioned that he might throw his collection away, Doyle offered to keep it for a while.

O'Connor shipped Doyle most of his collection about two years ago, though three of the four boxes he shipped were smashed or lost on the way to California. The bottles that arrived intact sat in Doyle's office until he thought of a use: a display in one of the university's student centers.

The three-month display went up in February. Titled “Water: Fact or Fashion,” it features O'Connor's collection, facts about bottled water's toll on the environment and a whiteboard where students can respond to a series of questions about water use.

“We want to challenge each viewer to draw their own conclusions and boundaries — When would you use a disposable water bottle?” Doyle said.

Water and Wastewater Slide Shows: https://communities.acs.org/blogs/h2oc/

The Social Cost of Burning Carbon

An Editorial: A Decade of 'No Growth' in Energy and Water Use

Residential Solar System Costs - Columbia, Missouri

Lead Contamination of the Flint, Michigan Water Supply: A Distillation of Readily Available Information - Updated to May 2016

Little Rock, AR., Municipal Water Works - 1996

Early History of Water Treatment

Kinetics of Chlorine Depletion and Microbial Growth in Household Plumbing Systems

Microscopy - for Water Treatment Plant Performance Evaluations

Turbidity

The Story of Bottled Water and other Slide Shows: iBook

Summary of Posts: 2010-2016

Bottled Water Exhibit: University of California-Davis (Video)

Water Chemistry

Water Softening by Precipitation with Lime

Taste and Odor Control at Bloomington, Illinois

Drinking Water Filtration: Replacement of GAC Caps at Bloomington, Illinois

What we can't (or shouldn't) put into our Sanitary Sewerage Systems

Anthropogenic Global Warming

A Drinking Water Supply Manifesto

20/20

Control of Nitrification in a Water Distribution System

Air-Assisted Filter Backwash (Air Scour)

Virus in Water Supplies

Chlorine vs. Chloramine

Drinking Water Process Performance Evaluations

Total Organic Carbon - Health Effects

Total Organic Carbon Removal

Total Organic Carbon

Pharmaceuticals in Water and Wastewater

Wastewater Reclamation, Recovery and Reuse

Stream Biomonitoring

Methane in Ground Water

Household Electrical Energy Usage

Sustainability for Water Systems

Arsenic in Drinking Water

Pit Happens: Copper Corrosion in Household Plumbing

My Kitchen Tap versus My Refrigerator Dispenser

A Brief History of Human Waste Disposal - Part 6. The Future

A Brief History of Human Waste Disposal-Part 5. Wastewater Treatment

A History of Human Waste Disposal - Part 4. Sewage Treatment

A Brief History of Human Waste Management - Part 3: Sewerage

A Brief History of Human Waste Disposal - Part 2: Toilets

A Brief History of Human Waste Disposal-and its possible future.

The Story of Bottled Water

1. Dr. O'Connor's collection and testing of bottled waters began at the University of Missouri-Columbia in 1980.

2. The *'Story'* was written in 2007 and posted to the H2O'C Engineering website in 2008.
http://www.h2oc.com/h2oc-library/libraryindex.html

3. The slide show was posted to the American Chemical Society website, December, 2010 as *Water and Wastewater Slide Shows.*
https://communities.acs.org/blogs/h2oc?start=15

4. Vintage water bottles were gifted to the University of California-Davis, March, 2013.

5. Columbia (MO) community (KOPN) Radio Interview on Bottled Water, April, 2013.
http://www.h2oc.com/h2oc-library/libraryindex.html

The on-going, whimsical slide show, The Story of Bottled Water, explores the phenomenal growth of the industry, the recent challenges to its environmental impacts, and some of the extremes reached in the creative marketing of packaged water. To this day, the story continues.

My interest in bottled water developed in 1980 after I obtained 101 finished drinking waters from Missouri public water supplies and analyzed them for total organic carbon (using the then newly introduced low-level TOC analyzer) and total bacterial cell counts (using epfluorescence microscopy). I compared the results with waters then being sold in glass, often colored glass, bottles. Thereafter, traveling friends and associates began bringing me bottles of water from an increasing array of venues. Tracking the development and marketing of these products then became a hobby.

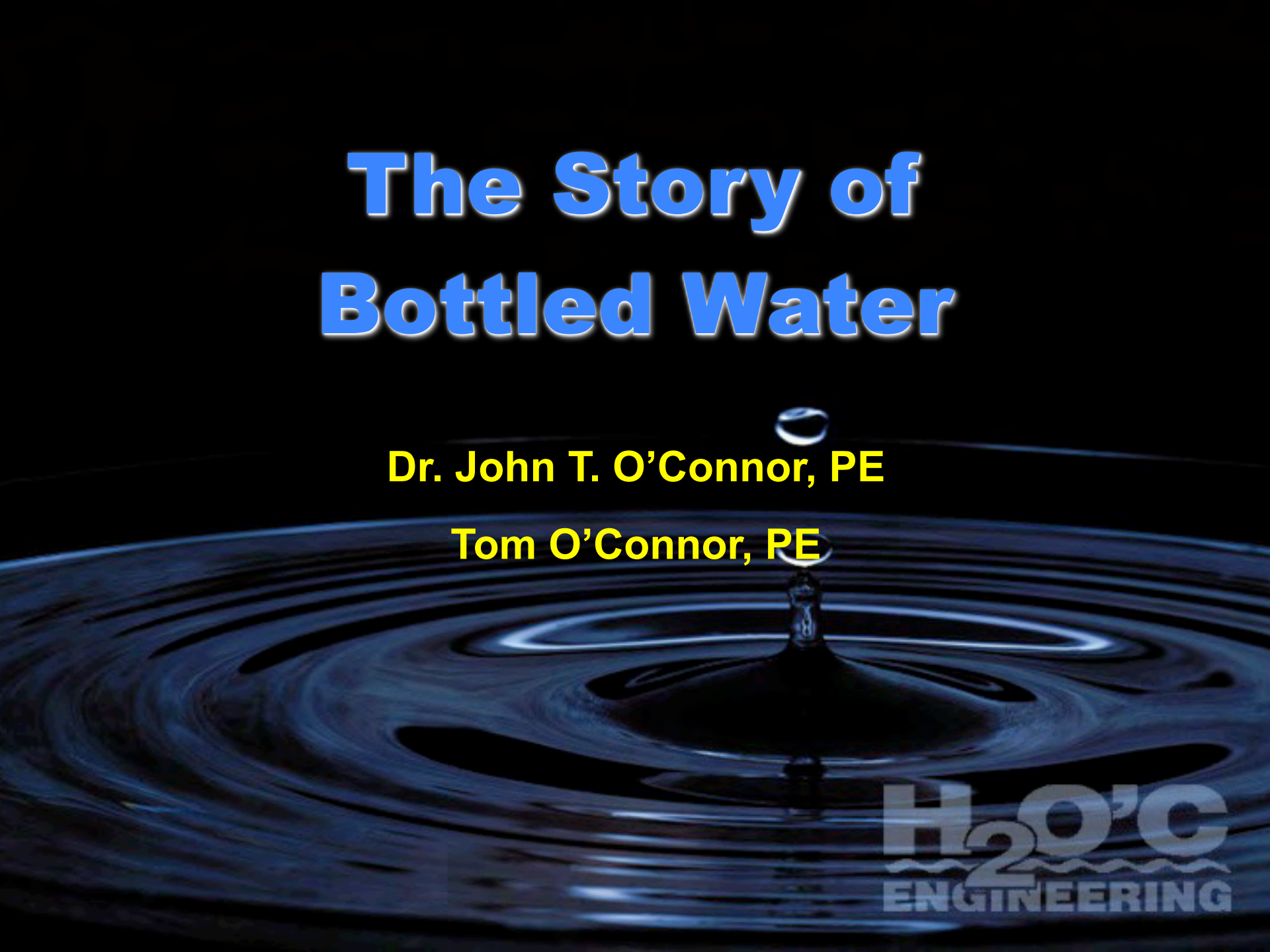
Full disclosure. I drink tap water.

John T. O'Connor, EngD, P.E."

The Story of Bottled Water

Dr. John T. O'Connor, PE

Tom O'Connor, PE

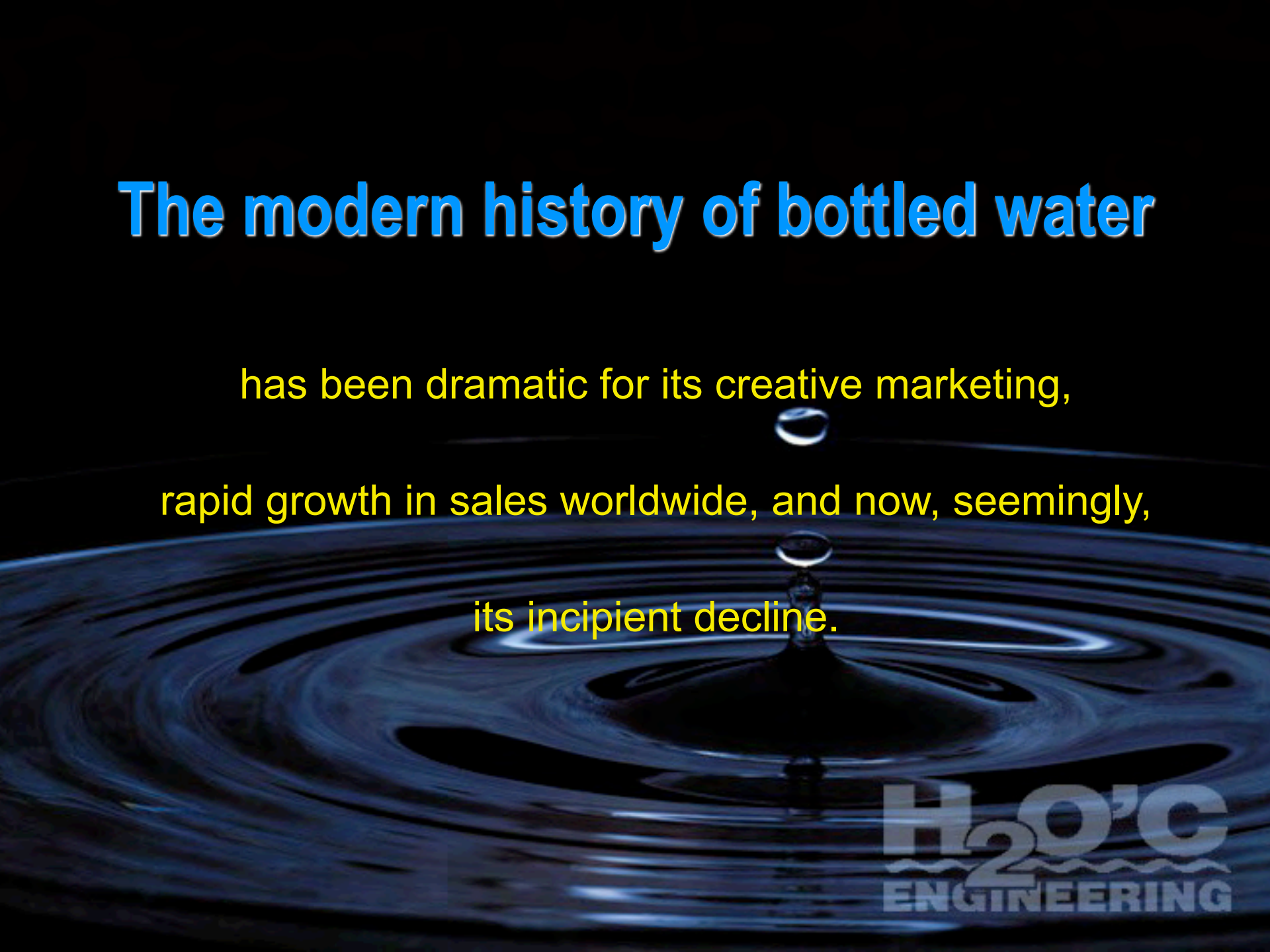


The modern history of bottled water

has been dramatic for its creative marketing,

rapid growth in sales worldwide, and now, seemingly,

its incipient decline.

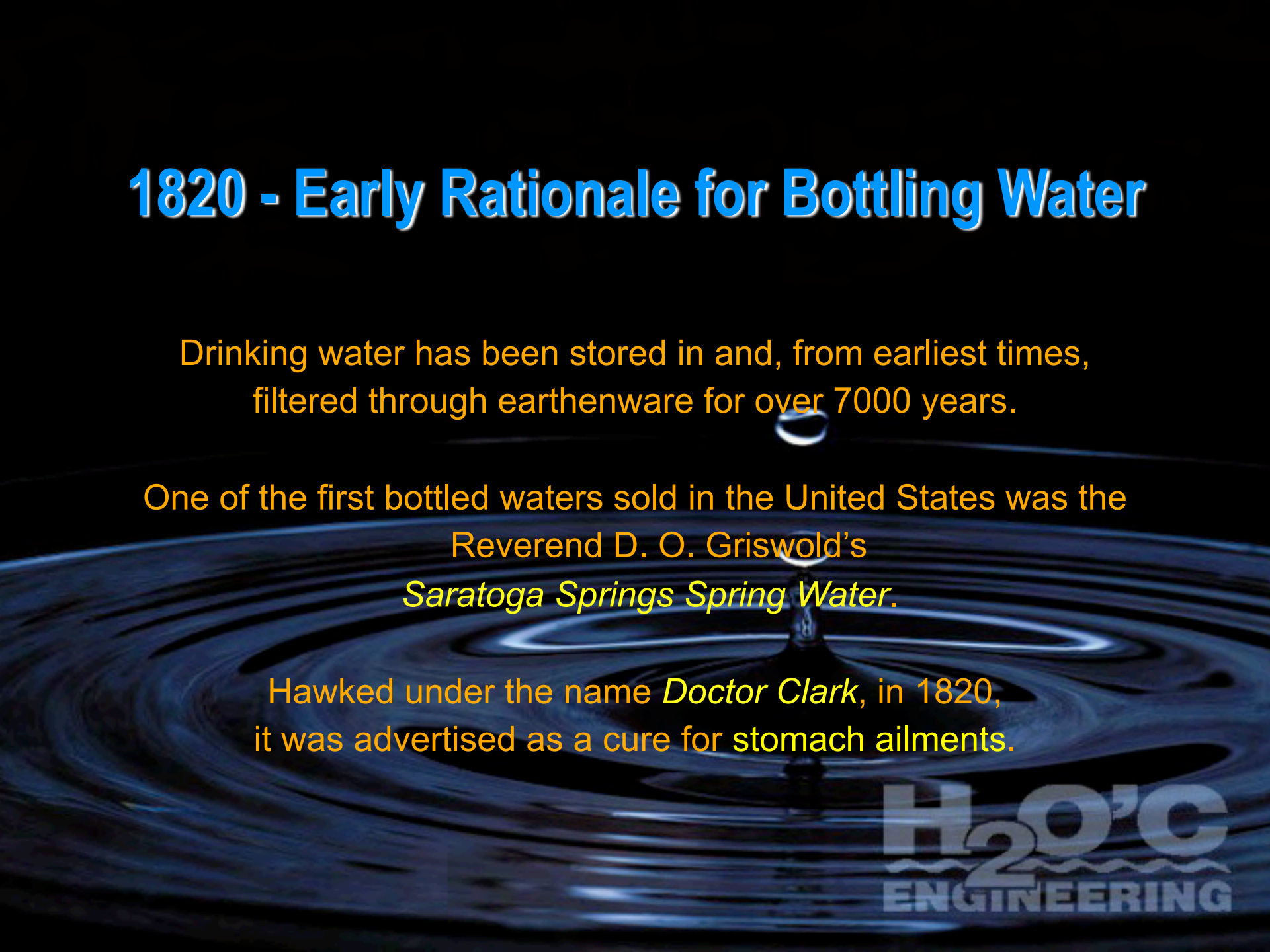


1820 - Early Rationale for Bottling Water

Drinking water has been stored in and, from earliest times, filtered through earthenware for over 7000 years.

One of the first bottled waters sold in the United States was the Reverend D. O. Griswold's *Saratoga Springs Spring Water*.

Hawked under the name *Doctor Clark*, in 1820, it was advertised as a cure for stomach ailments.

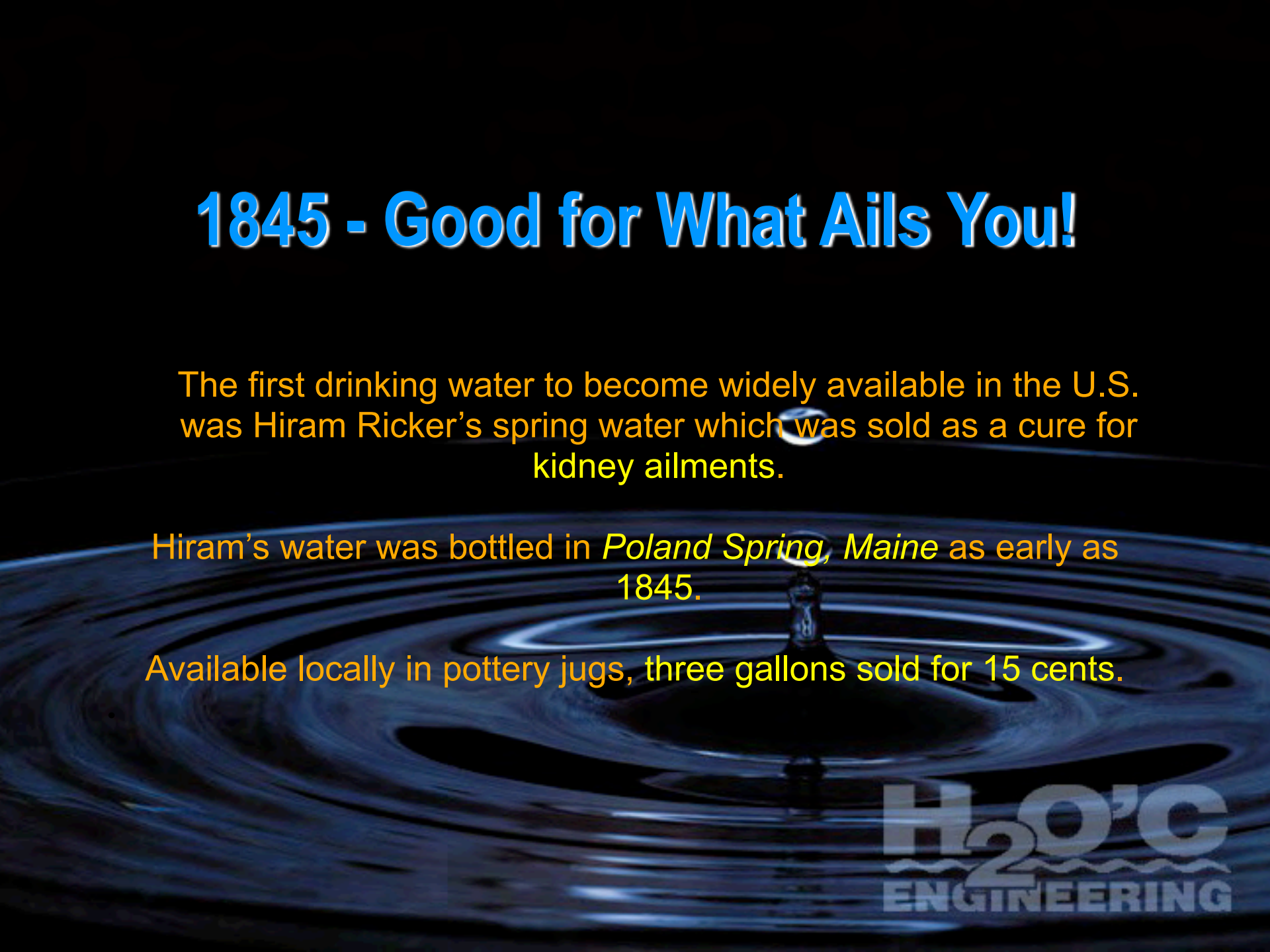


1845 - Good for What Ails You!

The first drinking water to become widely available in the U.S. was Hiram Ricker's spring water which was sold as a cure for kidney ailments.

Hiram's water was bottled in *Poland Spring, Maine* as early as 1845.

Available locally in pottery jugs, three gallons sold for 15 cents.



5,000 B.C.E.

Earthenware for water
sedimentation
filtration
storage

Middle East

1845 C.E.

Hiram Ricker's springwater as
cure for kidney ailments

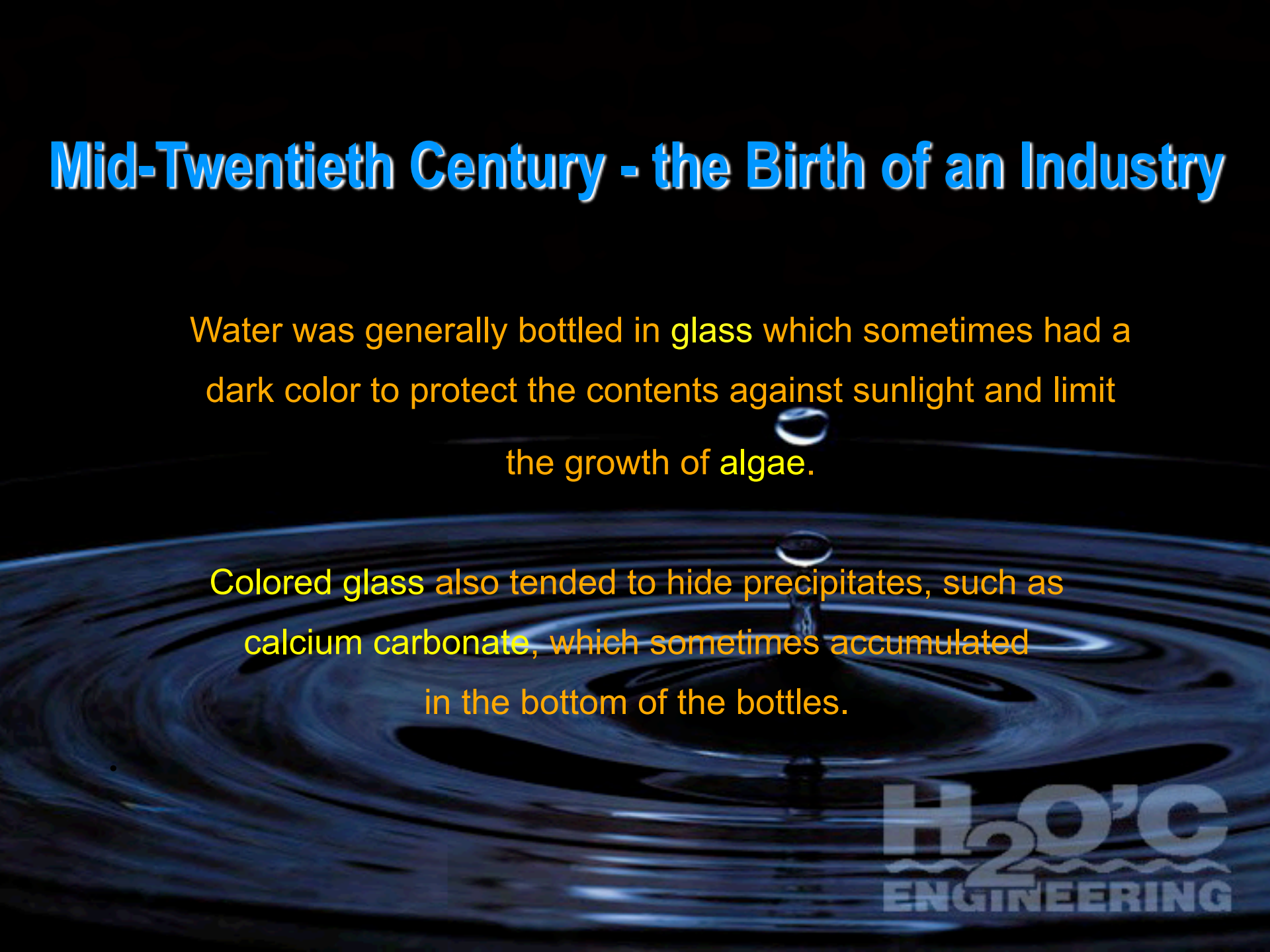
Poland Spring, Maine

20'C ENGINEERING

Mid-Twentieth Century - the Birth of an Industry

Water was generally bottled in glass which sometimes had a dark color to protect the contents against sunlight and limit the growth of algae.

Colored glass also tended to hide precipitates, such as calcium carbonate, which sometimes accumulated in the bottom of the bottles.



1960 - Colored Glass Bottles

Dark colored glass to protect against sunlight, algae.

$CaCO_3$ precipitates

Flavored Canadian Water

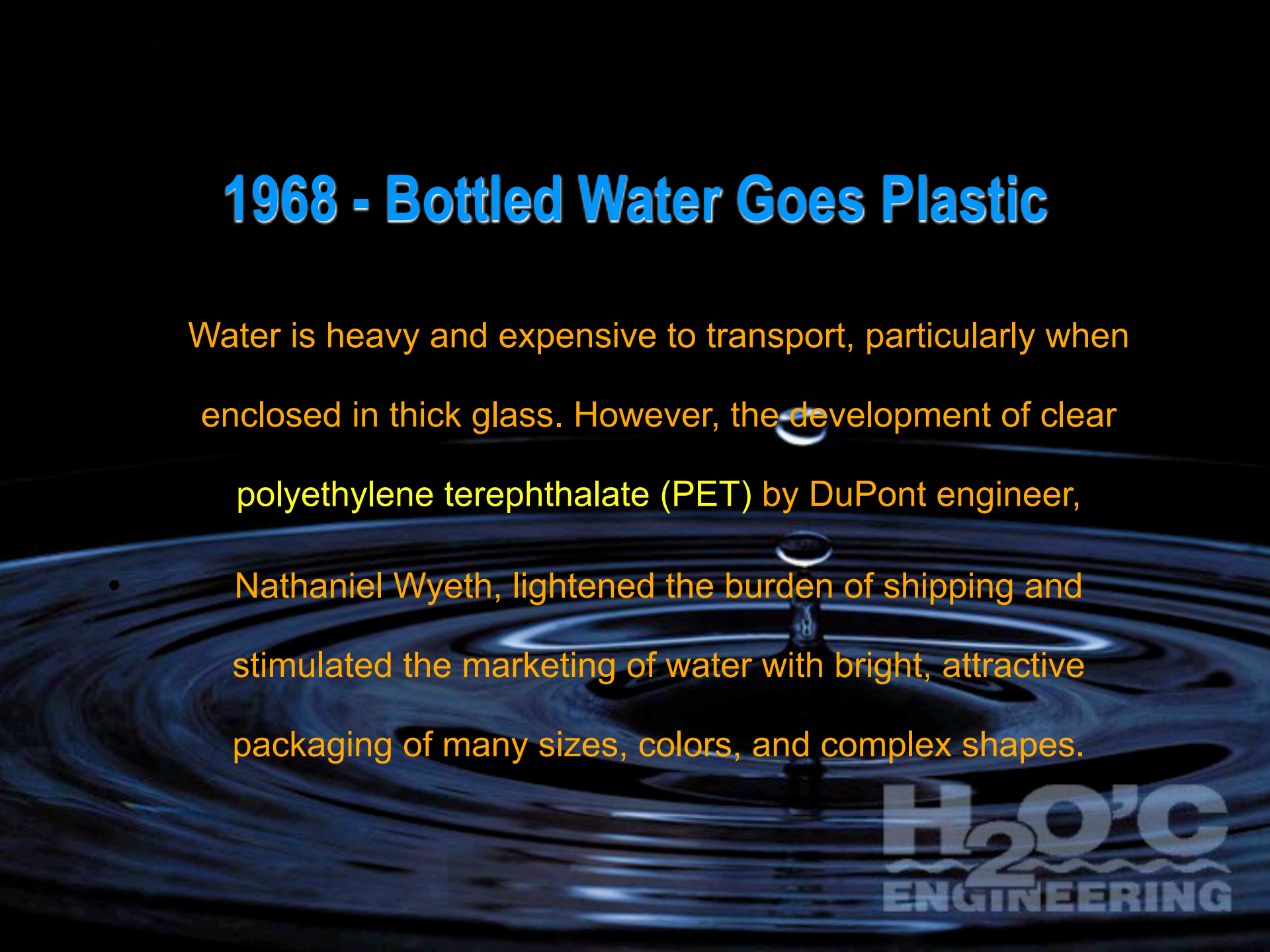
Germany France Europe Yugoslavia

Ireland
England
Belgium
Italy
KERRY Spring
Still
Irish Mineral Water
THE ORIGINAL BRITISH SPA WATER
HARROGATE SPA
STILL SPRING WATER
BLÜ
botol
16.9 fl oz
500 mL
Natural Spring Water
ACQUA PANNA
FROM THE HILLS OF TUSCANY
ACQUA
PANNA
Acqua Oligominerale
Bottled at the source in Italy
S.PELLEGRINO 500 ml
NATURAL MINERAL WATER

1968 - Bottled Water Goes Plastic

Water is heavy and expensive to transport, particularly when enclosed in thick glass. However, the development of clear polyethylene terephthalate (PET) by DuPont engineer,

- Nathaniel Wyeth, lightened the burden of shipping and stimulated the marketing of water with bright, attractive packaging of many sizes, colors, and complex shapes.



PET saves on shipping

Non-returnable containers

1968 Dupont

polyethylene terephthalate

PET invented by
Nathaniel Wyeth
(brother of painter Andrew)

1 kg of PET
requires about
2 kg of oil
and produces
3 kg of CO_2

H2O'C ENGINEERING

1977 Perrier

introduces the fashion accessory for yuppies: its bowling-pin-shaped, green bottle

Bottle Sizes

(and water contents)

begin to decrease

H2O'C ENGINEERING

Downsizing - with style

more container - less content

1977 - The Miracle of Marketing:
Perrier Ice Cubes for Eskimos

Perrier entered the U.S. market with a distinctive green, pin-shaped bottle. Promoted in an imaginative nationwide marketing program, its sales reached $20 million in its first year and tripled in the following year.

As a *'fantasy gift'*, Neiman-Marcus reportedly offered a swimming pool filled with Perrier.

H2O'C ENGINEERING

1978 - The Bottle as Fashion Statement

Bottled in France since 1826 for its *medicinal* properties,

Evian surfaced in 0.5 litre PVC bottles in 1969.

Thereafter, Evian launched a sculpted bottle for the *Winter Olympic Games at Albertville*.

In 1992, Evian premiered the launch of a PET bottle which was *'completely collapsible'*, presumably to save landfill space.

Evian Millennium limited edition bottle (1999) marked the millennium.

The *Evian Nomade (2000); Evian Affinity (2001)*; *Evian 1 litre compact bottle (2004)*; and *Palace Bottle (2007)* (which could be found solely in *fine dining establishments*) followed in rapid succession.

H2O'C ENGINEERING

Marketing Poland Spring

Ride! Rock! Choose! Win! Movies! DVD!

-- and, oh yes! water!

RULE THE RIDES!
SHREK 2
NOW ON DVD
4-D
HOLLYWOOD
FEEL LIKE A MOVIE STAR!
Choose Your Adventure!
UNIVERSAL STUDIOS THEME PARKS
Enter to win at PolandSpring.COM
LIVE LIKE A ROCK STAR!
Sources: Poland Spring, Poland Spring, ME; Evergreen Spring, Fryeburg, ME and/or Garden Spring, Poland, ME. Poland Spring Water Company Division of Nestlé Waters North America Inc. Greenwich, CT 06830
© 2005 CT #408, NYSHD Cert. #072
ME 5¢ REFUND
Poland Spring
NATURAL SPRING WATER FROM MAINE SINCE 1845
.5 L
(1 PT, 0.9 FL OZ)

Now brought to you by Nestlé, the Swiss Company that sells water throughout North America!

Enjoy your ride!

H2O'C ENGINEERING

U.S. - Arrowhead

Nestlé Mountain Spring Water

"It's Better Up Here!"

It's Better Up Here!®
Arrowhead comes to you exclusively from natural mountain sources in the United States and Canada.
Thirst Quencher
Arrowhead Mountain Spring Water Company
Division of Nestle Waters North America Inc.
Greenwich, CT 06830
© 2006
Questions? Comments? Call 1-800-873-7775
ARROWHEAD
Est. 1894
BRAND
Mountain Spring Water
1 L (1 QT, 1.8 FL OZ)
Since 1894, people have been enjoying the pure, crisp taste of Arrowhead® Brand Mountain Spring Water—a water that comes from natural mountain springs, with a taste as refreshing as nature itself. We hope you enjoy Arrowhead as much as we love bringing it to you.
arrowheadwater.com

Despite advertising illusions,

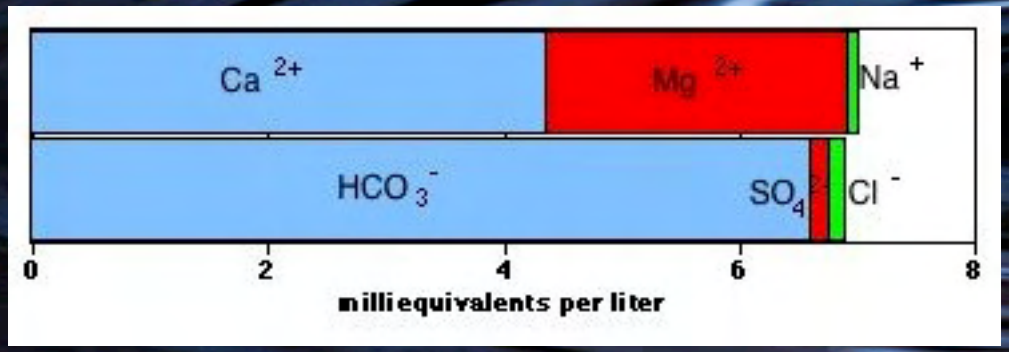
most of the water sold in the U.S. is **groundwater**;

25% is derived from municipal water sources.

H2O'C ENGINEERING

Produit du Canada

Cold water tastes good! It's cold in Canada!
Canadian water tastes good!



The Canucks actually provided water quality data on their label

-- in two languages. **Olé!**

No lake here! The data indicate a moderately hard groundwater.

Arkansas Missouri Maine Yugoslavia

U.S. States enter the market

St. Louis Kansas City Chicago Okla. City

U.S. Cities enter the market

Chicago! ‘Great Lake’ or ‘Deep Artesian’!

Chicago offers a choice: Cubs or White Sox?

Gallon Jugs of Glacial, Artesian, Mountain, Lake, Spring, ...

8 ounces more than 1 gallon ?

This gallon jug ruptured releasing all of

Buffalo Don's

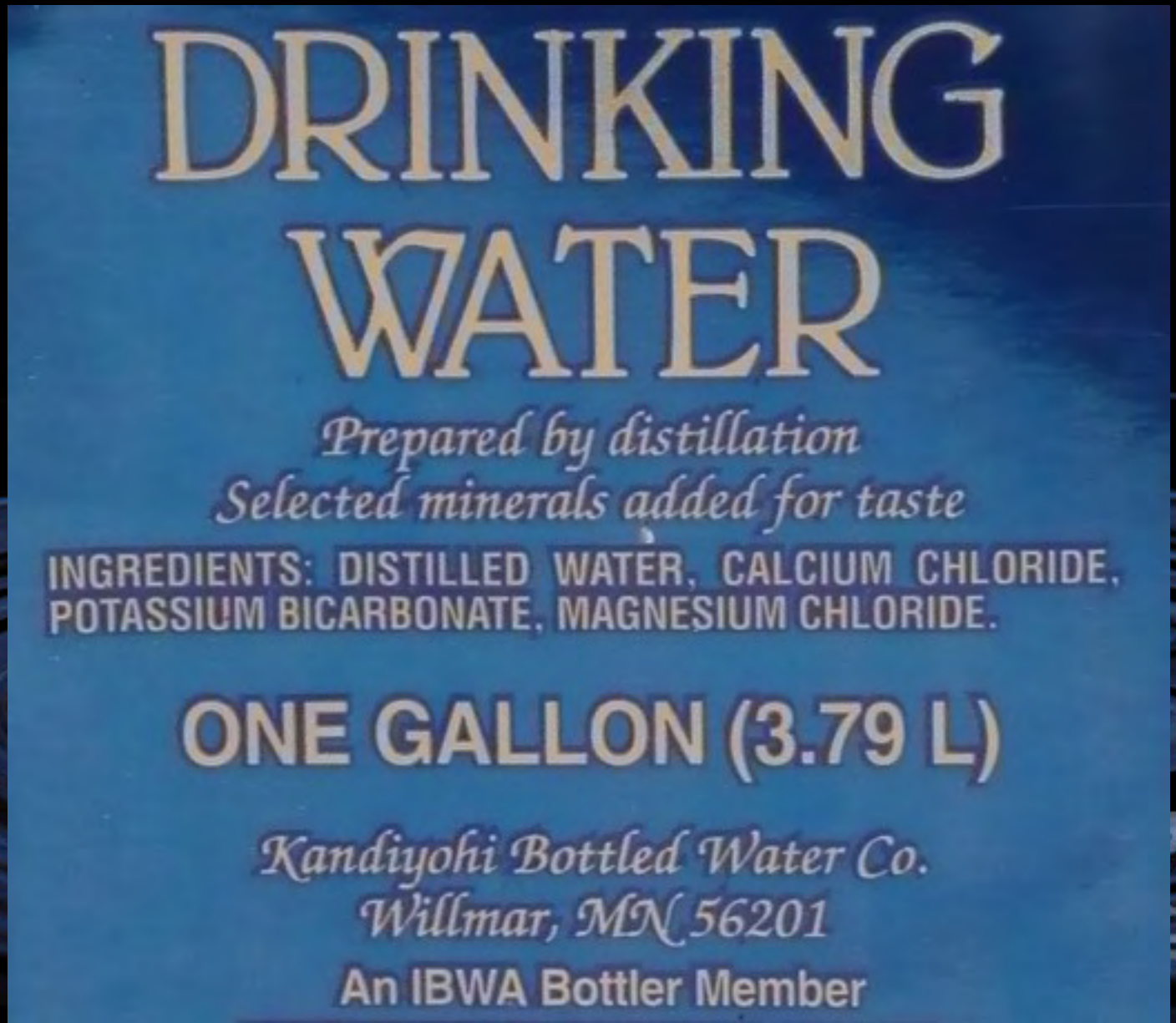
Crystal Pure Wisconsin Artesian Glacial Water

onto my bookshelf

H2O'C ENGINEERING

Minnesota Distilled Water

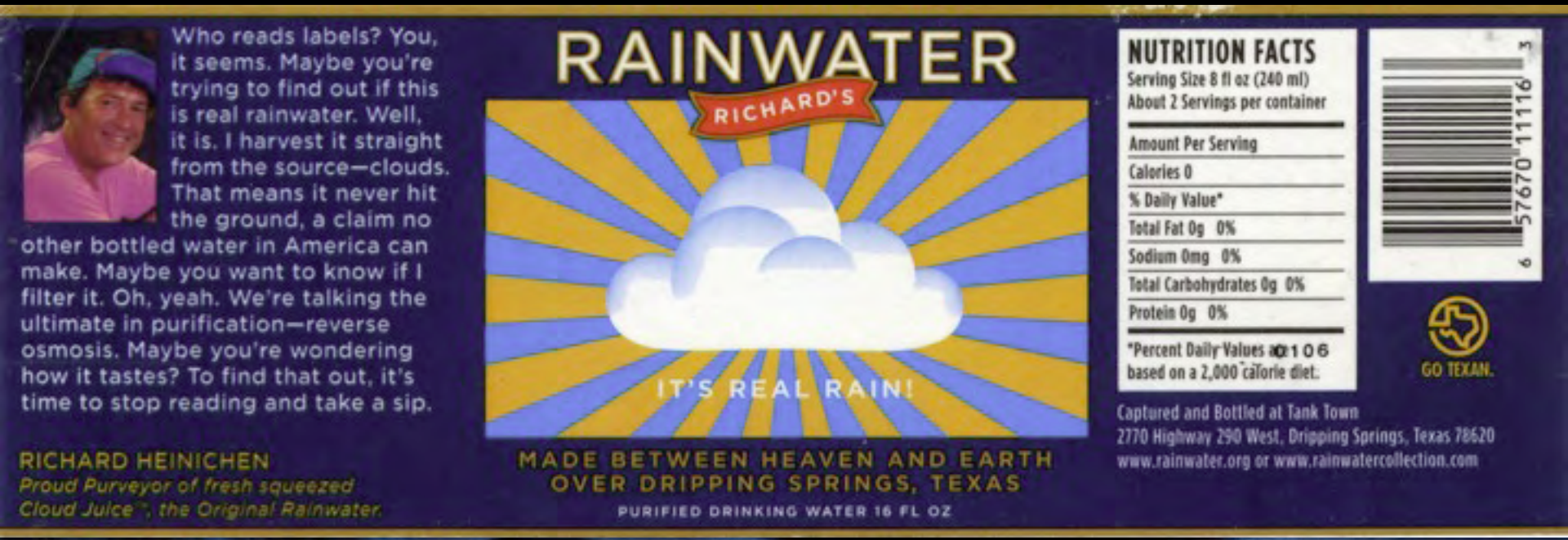
-- with tasty salts added back in!



“Never Hit the Ground …”

“…proud purveyor of fresh squeezed cloud juice.”

‘jes don’ get no bettern’ that!


Who reads labels? You, it seems. Maybe you're trying to find out if this is real rainwater. Well, it is. I harvest it straight from the source—clouds. That means it never hit the ground, a claim no other bottled water in America can make. Maybe you want to know if I filter it. Oh, yeah. We're talking the ultimate in purification—reverse osmosis. Maybe you're wondering how it tastes? To find that out, it's time to stop reading and take a sip.
RICHARD HEINICHEN
Proud Purveyor of fresh squeezed Cloud Juice™, the Original Rainwater.
RAINWATER
RICHARD'S
IT'S REAL RAIN!
MADE BETWEEN HEAVEN AND EARTH
OVER DRIPPING SPRINGS, TEXAS
PURIFIED DRINKING WATER 16 FL OZ
NUTRITION FACTS
Serving Size 8 fl oz (240 ml)
About 2 Servings per container
Amount Per Serving
Calories 0
% Daily Value*
Total Fat 0g 0%
Sodium 0mg 0%
Total Carbohydrates 0g 0%
Protein 0g 0%
*Percent Daily Values are based on a 2,000 calorie diet.
GO TEXAN.
Captured and Bottled at Tank Town
2770 Highway 290 West, Dripping Springs, Texas 78620
www.rainwater.org or www.rainwatercollection.com

“It’s Real Rain!”

H2O’C ENGINEERING

Private Label Packaged Water

your organization's name and logo

34 cents per bottle when ordering pallet quantities!

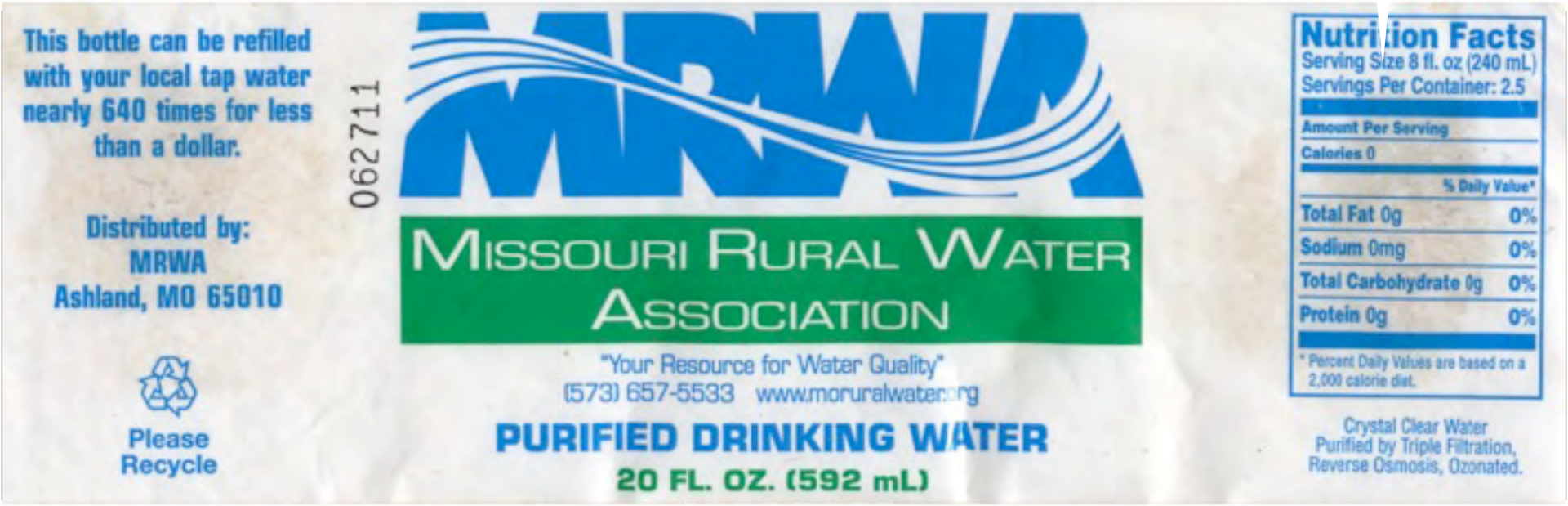
By 2011, cost is ~$1 per bottle.

H2O'C ENGINEERING

Missouri Rural Water

"No Protein!"

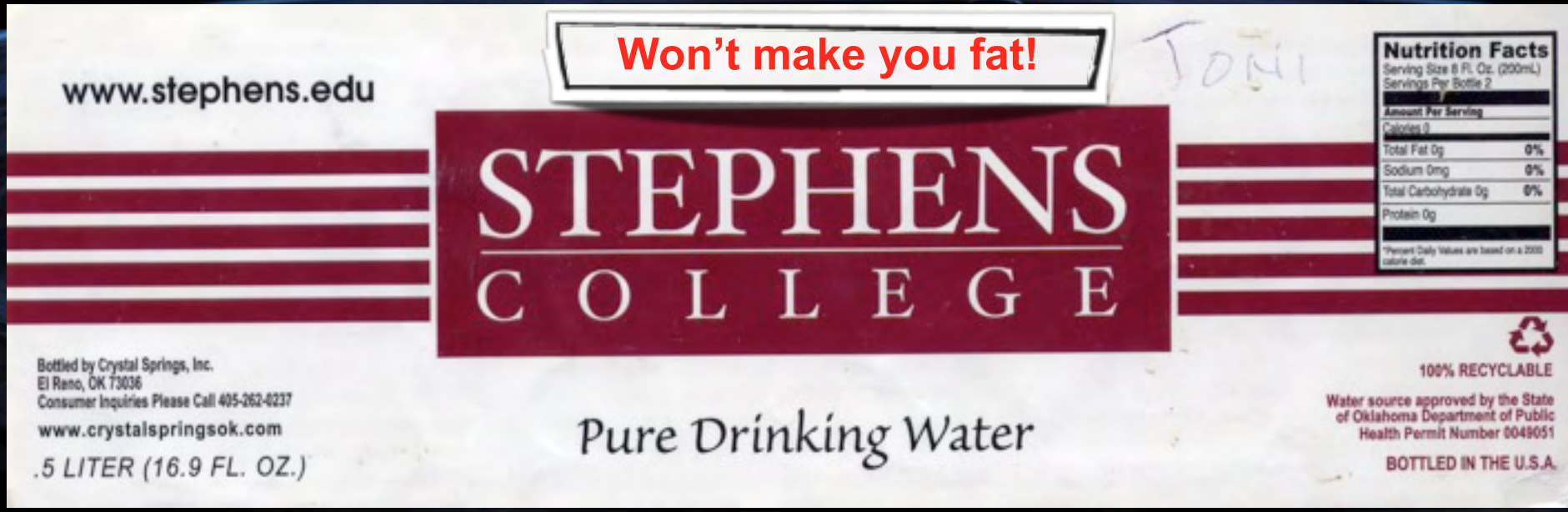
2.5 servings per container


This bottle can be refilled with your local tap water nearly 640 times for less than a dollar.
Distributed by:
MRWA
Ashland, MO 65010
Please Recycle
062711
MRWA
MISSOURI RURAL WATER ASSOCIATION
"Your Resource for Water Quality"
(573) 657-5533 www.moruralwater.org
PURIFIED DRINKING WATER
20 FL. OZ. (592 mL)
Nutrition Facts
Serving Size 8 fl. oz (240 mL)
Servings Per Container: 2.5
Amount Per Serving
Calories 0
% Daily Value*
Total Fat 0g 0%
Sodium 0mg 0%
Total Carbohydrate 0g 0%
Protein 0g 0%
* Percent Daily Values are based on a 2,000 calorie diet.
Crystal Clear Water
Purified by Triple Filtration,
Reverse Osmosis, Ozonated.

Most bottle labels tout purity, implying that there is *nothing* (e.g., *0% Fat*) in the water - *based on a 2,000 calorie diet*

H2O'C ENGINEERING

Local Brands: for truckers and college women



Targeting Water Drinkers

Kidz Water!

-- not just for yuppies and old fartz anymore!

It's fluoridated!

many enthusiasts believe that bottled water contains no fluoride ...

H2O'C ENGINEERING

For Sports Drinkers on the Run!

Emergency Drinking Water Supply

Missouri:

West Plains

Floods

Cabool

Terrorist Attacks

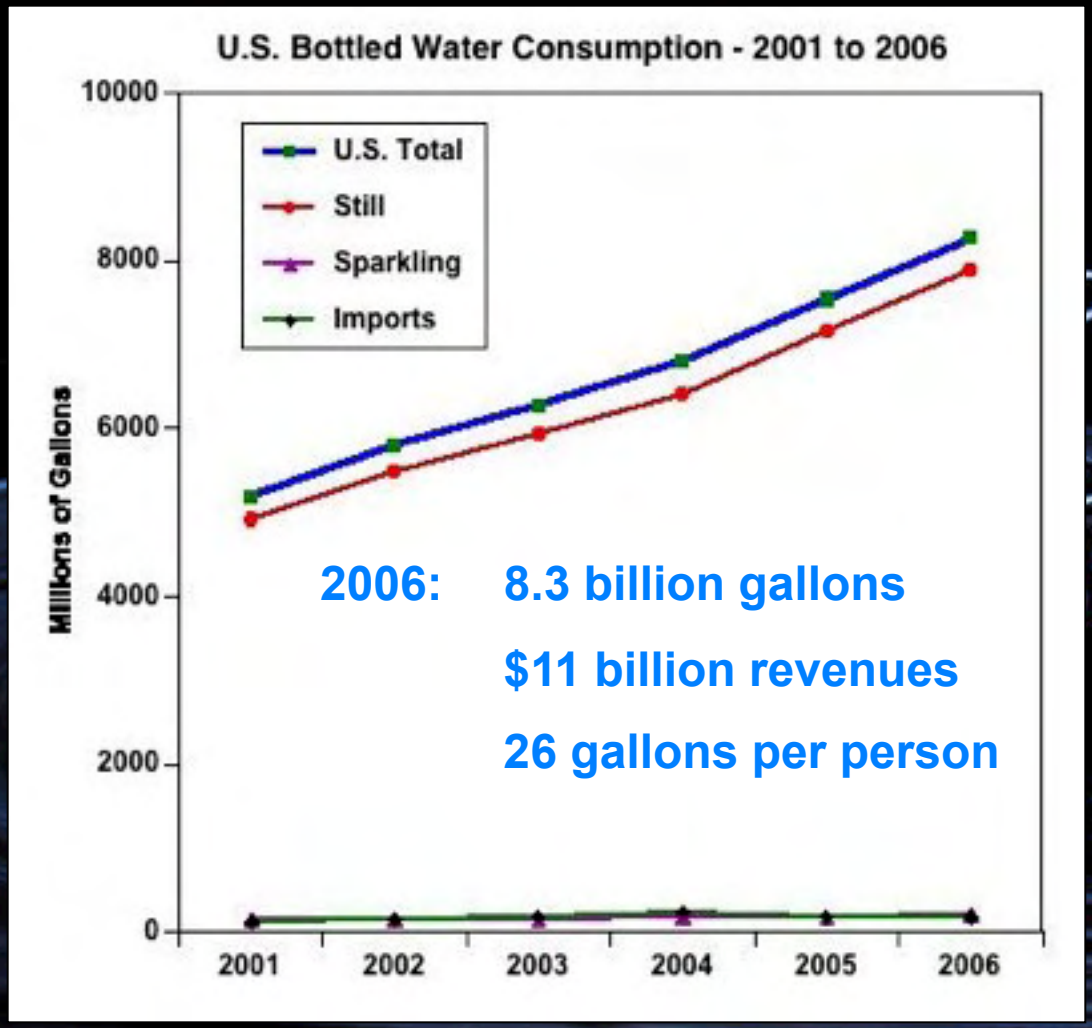
Gideon

Mushroom Clouds on Main Street

H2O'C ENGINEERING

U.S. Packaged Water Consumption

≈ 10% Annual Growth



2006: 8.3 billion gallons

$11 billion revenues

26 gallons per person

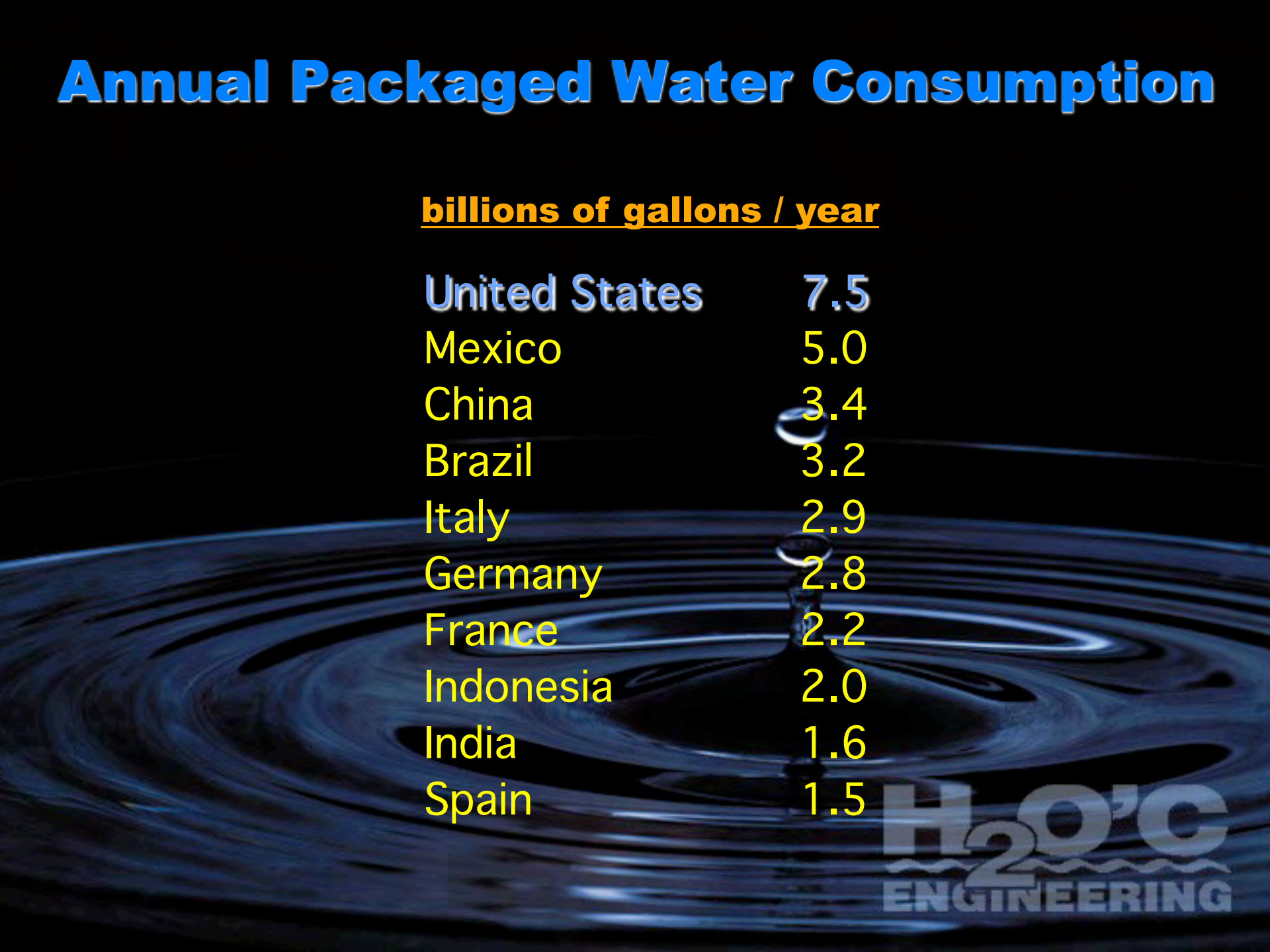
Suppliers to Packagers

- Activated Carbon Products
- Bottle Closures
- Bottling Equipment
- Carry Handles
- Color Label Printers
- Computer Services, Software
- Coolers; Chillers
- Labels and Packaging
- Oxygen Related Products
- Ozone, UV, R.O. Systems
- PET Plastic
- Plastic Bottle Equipment
- Process Technology
- Trucks and Transportation
- Water Sources (Wells)
- Water Treatment Plants

H2O'C ENGINEERING

Annual Packaged Water Consumption

	billions of gallons / year
United States	7.5
Mexico	5.0
China	3.4
Brazil	3.2
Italy	2.9
Germany	2.8
France	2.2
Indonesia	2.0
India	1.6
Spain	1.5



Packaged Water Consumption, Gallons Per Capita

Italy	51
United Arab Emirates	48
Mexico	47
Belgium-Luxembourg	42
Spain	39
France	37
Germany	34
Lebanon	28
Switzerland	27
United States	26
Cyprus	26
Saudi Arabia	25
Czech Republic	24
Portugal	22
Slovenia	22
Global Average	7

H2O'C ENGINEERING

Regulation of Bottled Water Quality

Proposed (2007) California *Water Quality Notice*:

- Make available annual *consumer confidence report*
- Label to indicate *source*; provide *contact information*

International Bottled Water Association (IBWA):

- Opposed to onerous California legislation

Pepsi spokesman said *anyone* can find out the true source of *Aquafina* by calling the 800 number on the bottle top.

H2O'C ENGINEERING

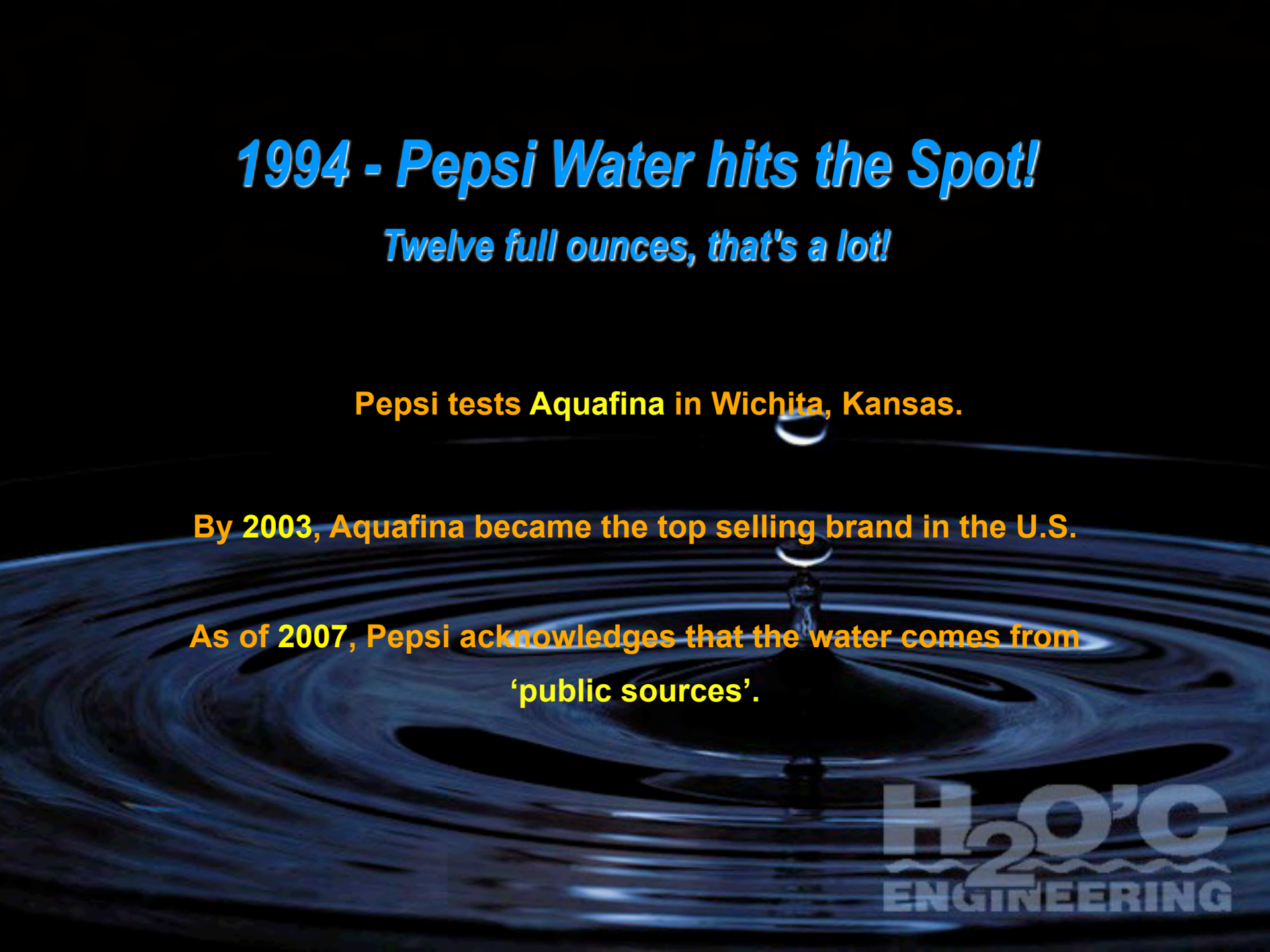
1994 - Pepsi Water hits the Spot!

Twelve full ounces, that's a lot!

Pepsi tests Aquafina in Wichita, Kansas.

By 2003, Aquafina became the top selling brand in the U.S.

As of 2007, Pepsi acknowledges that the water comes from ‘public sources’.



1999: Coca-Cola

applies secret formulas

and enters global water market with previously unheard-of flavors

Coca-Cola introduces ***Dasani*** which becomes

the second largest selling brand in the U.S.

While Dasani bombs as *'bottled spunk'* in Great Britain,

Coca-Cola boasts sales of

400 varieties of bottled water in

200 countries worldwide.

Coca-Cola Co-opts AWWA

The Coca-Cola Company
2007 Water For People Golf Event
Presented by RE/MAX International, Inc.

"Did you know The Coca-Cola Company offers more than 400 brands in over 200 countries?

There were 193 recognized countries in the world!

"Well, we do!

"From Inca Kola, a soft drink found in North and South America, and Samurai, an energy drink available in Asia; to Vita, an African juice drink, and BonAqua, a water found on 4 continents, our product variety spans the globe!"

H2O'C ENGINEERING

The Coca-Cola Company

The Coca-Cola Company Virtual Vender

Brand Name: BonAqua/BonAqa

Drink Type: Water

BonAqua/BonAqa: BonAqua provides the pure taste of crystal water. Known as BonAqa in some locations, this refreshing product is available carbonated or noncarbonated, depending on location.

Available in the following flavors: Apple, Apple Mint, Cranberry Grapefruit, Guaraná, Lemon, Lemon Lime, Lime, Lingonberry, Lychee, Orange, Pear, Raspberry, Strawberry, Tangerine and Unflavored.

Available in the following locations: Australia, Azerbaijan, Belarus, Belgium, Brazil, Cape Verde, Comoros, Czech Republic, Democratic Republic of Congo, Ecuador, Estonia, Finland, Germany, Ghana, Guinea-Bissau, Hong Kong, Hungary, Iceland, Italy, Japan, Kazakhstan, Kyrgyzstan, Latvia, Lesotho, Liberia, Lithuania, Macau (Macao), Macedonia, Mauritania, Mayotte, Moldova, Mongolia, Morocco, Namibia, Netherlands, Norway, Peru, Poland, Russia, Slovakia, South Africa, Spain, Sweden, Taiwan, Tunisia, Turkmenistan, Ukraine, Uruguay and Uzbekistan.

'Unflavored' is a flavor?

H2O'C ENGINEERING

The Coca-Cola Company

The Coca-Cola Company Virtual Vender

Brand Name: DASANI Flavors

Drink Type: Water

DASANI Flavors: DASANI Grape, DASANI Lemon, DASANI Raspberry and DASANI Strawberry flavored water beverages are naturally flavored and lightly sweetened with sucralose and acesulfame potassium (Ace K) to provide a water alternative without calories or carbohydrates.

Available in the following flavors: Grape, Lemon, Raspberry and Strawberry.

Available in the following location: United States.

For those who prefer their *water "lightly sweetened with sucralose and acesulfame potassium"*.

In Missouri, the most popular bottled water flavors are:

Busch, Budweiser & Michelob.

H2O'C ENGINEERING

Vitamins B_3,B_6,B_{12}, E, Zinc, Fiber, ...

Soon! - with Steroids!

The Coca-Cola Company

The Coca-Cola Company Virtual Vender

Brand Name: DASANI Plus

Drink Type: Water

DASANI Plus: DASANI Plus vitamin-enhanced flavored water beverages have zero calories per serving and come in three varieties:

1) Refresh + Revive: Kiwi Strawberry Flavor has 10% of the reference daily intake (RDI) per serving of Vitamins B3, B6 and B12.

2) Cleanse + Restore: Pomegranate Blackberry Flavor contains 10% of the RDI per serving of Vitamins E, B3, B6 and B12, plus 1 gram of fiber.

3) Defend + Protect: Orange Tangerine Flavor provides 10% of the RDI per serving of Vitamin E and Zinc.

Available in the following location: United States.

Only in America!

ENGINEERING

China Water

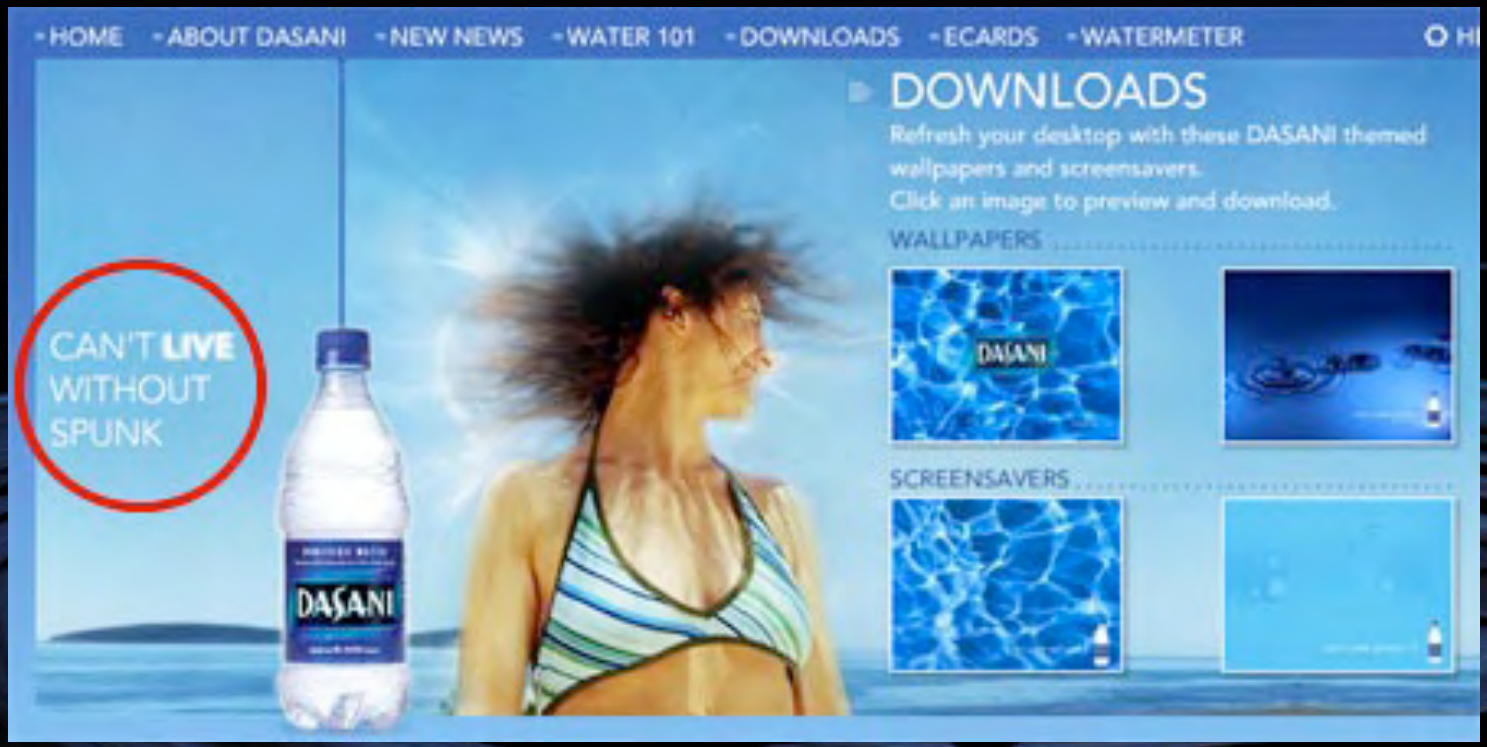
The Coca-Cola Company
The Coca-Cola Company Virtual Vender
Brand Name: Ice Dew
Drink Type: Water
Ice Dew: Ice Dew is a bottled water available in China.
Available in the following flavor: Unflavored.
Available in the following location: China.

Reducing the U.S. - China flavor imbalance …

H2O'C ENGINEERING

Dasani was launched in the UK in January 2004

It was referred to as *bottled spunk* and featured the tagline *can't live without spunk*. In the UK, *spunk* is a euphemism for *semen*.



Dasani was pulled from the UK market in March 2004

In March 2004, a news article revealed that the tap water of the Town of *Sidcup* in Kent was being treated, bottled and sold under the **Dasani** brand name in the UK.

Two weeks later, UK authorities found a concentration of *bromate* in the product. Coca-Cola recalled half a million bottles and pulled the **Dasani** brand from the UK market.

Ironically, the *bromate* was induced by *ozonation* of the tap water's *bromide ion* and was not initially present in the City's tap water.

H2O'C ENGINEERING

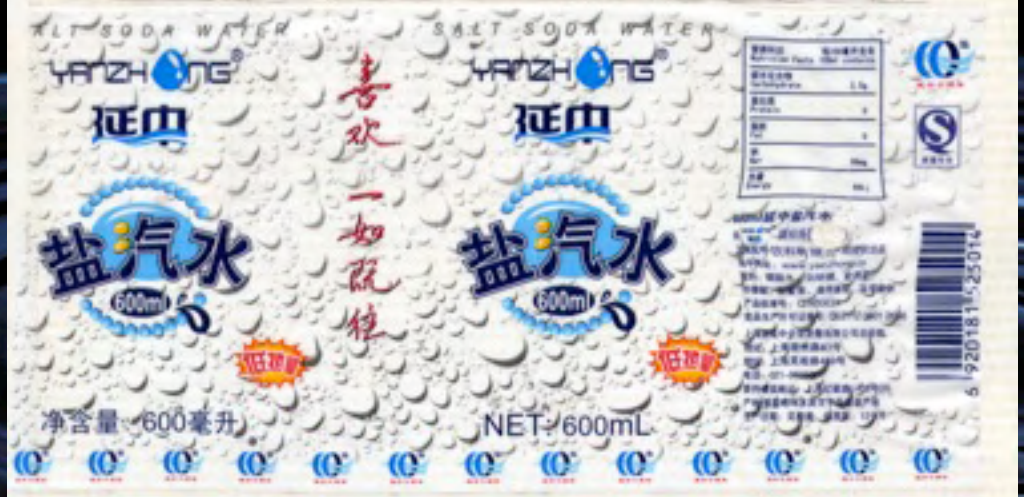
Potables of the former CCCP

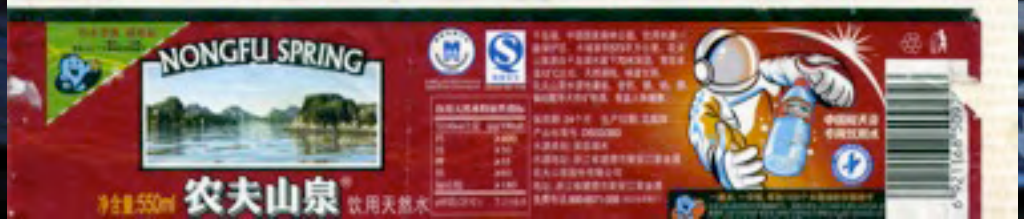
Japan

饮用纯净水
PURIFIED WATER
FOR DRINKING

康師傅
饮用矿物质水
康師傅
饮用矿物质水

Laoshan
崂山矿泉水
Laoshan
崂山矿泉水


ALT SODA WATER
YANZHONG
延中
盐汽水
600ml
喜欢一如既往
SALT SODA WATER
YANZHONG
延中
盐汽水
600ml
净含量 600毫升
NET 600mL


NONGFU SPRING
农夫山泉
饮用天然水

Japan

Here's Nestlé!

H2O ENGINEERING

Thailand

aura
Natural Mineral Water
น้ำแร่ธรรมชาติแม่ริม
ออรา
น้ำแร่ธรรมชาติแม่ริม
Net content 0.5 Litre
50-2-00138-2-0001
TRAILAND
ปริมาตรสุทธิ 0.5 ลิตร
8 850779 555995

NƯỚC KHOÁNG THIÊN NHIÊN
laVie
HÀM LƯỢNG KHOÁNG NHẸ (mg/l)
Tổng chất rắn hòa tan (TDS) 155
HCO3 110
NA+ 21
CA++ 12
MG++ 11
K+ 4
NITRAT < 1.00
FLO 0.17
IOT < 0.01
SẮT < 0.01
pH 8.4
ĐÓNG CHAI TẠI NGUỒN NHƯ QUỲNH
BỞI CÔNG TY LIÊN DOANH LA VIE
QUỐC LỘ 5 - Km 21 QUỲNH - VĂN LÂM - HƯNG YÊN
8 935005 801012
laVie®
1,5L
La Vie, nước khoáng thiên nhiên nhẹ và tinh khiết,
được lấy lên từ nguồn nước khoáng sâu
được bảo vệ trong lòng đất, rất tốt cho sức khỏe
của gia đình bạn nhờ có lượng khoáng chất cân bằng.
Để đảm bảo chất lượng tuyệt đối,
La Vie được đóng chai trực tiếp tại nguồn dưới sự giám sát
chất lượng của Nestlé Waters, công ty hàng đầu thế giới
trong lĩnh vực nước đóng chai.
La Vie is bottled directly at source under the quality
supervision of Nestlé Waters.
Best before, see date on the bottle.
Sử dụng trước hạn ghi trên chai
www.lavievater.com

SIAM DRINKING WATER
MANUFACTURED BY
TTC SIAM DRINKING WATER CO.,LTD.
SIAM DRINKING WATER: THE FINEST PURIFIED HYGIENIC DRINKING WATER; USING THE FINE PROCESS OF FILTRATION, REVERSE OSMOSIS, ULTRAVIOLET LIGHT AND OZONATION.
NET CONTENT 599 ml.
น้ำดื่มตรา
สยาม
13-3-00441-2-0001
ปริมาตรสุทธิ 599 มล.
8 852854 000017
SIAM™
DRINKING WATER

Thailand

Ultravioleted?

H2O'C ENGINEERING

Vietnam

คริสตัล
CRYSTAL
NSF
น้ำดื่มคริสตัล น้ำดื่มรายเดียว
ในประเทศไทย ที่ได้มีมาตรฐาน
การผลิตน้ำดื่มของสหรัฐอเมริกา
โดยสถาบัน NSF International
คิดจะดื่มน้ำ...ดื่มคริสตัล
น้ำดื่ม
ตราคริสตัล
ผลิตโดย
63 ถ.บางบุรี-ปทุมธานี
อ.เมือง จ.ปทุมธานี
ปริมาตรสุทธิ 600 มิลลิลิตร
13-1-10824-2-0001
8 851952 350161

Natural Mineral Water
Minéré
Pho Sam
Ton Source
Net Vol. 0.5 L
น้ำแร่ธรรมชาติจากแหล่งโพรี่สามัน
ตรามิเนเร่
Mineral Content :
Calcium
Magnesium
Potassium
Sodium
Zinc
Fluoride
Bicarbonate
Sulfate
8 850011 200102
มิเนเร่
คุณค่าแร่ธาตุ
จากธรรมชาติ
ปริมาตรสุทธิ 0.5 ลิตร
Naturally Better For You ... Everyday
ควรเก็บในที่เย็น ปราศจากกลิ่น
และหลีกเลี่ยง จากแสงแดด
ศูนย์ดูแลผู้บริโภคแบสท์ส์
1-800-295588

NUỚC KHOÁNG THIÊN NHIÊN
NATURAL MINERAL WATER
Vital
500ml
ASEM5
VIỆT NAM - ITALIA
Đóng chai trực tiếp tại nguồn khoáng
Bông Cọ - Tiền Hải - Thái Bình
Bởi Công ty S.X kinh doanh XNK Bình Minh
BITEXCO
NUỚC UỐNG CHÍNH THỨC CỦA HỘI NGHỊ CẤP CAO ASEM 5
8 934698 020021

Vietnam

Still under the influence of French food and water colonialists?

In Vietnam,

Coca Cola brings you Joy!

Wales - Green Valley

TWYNI
We all know that water is vital to our wellbeing. Br[illegible] you know that your recommended daily fluid intake is 8 glasses of water a day?
Green Valley® is a still spring water from the heart of the lush green countryside of Wales.
So drink Green Valley to help you stay in top form all day long!
This bottle contains 100% of your recommended daily fluid intake.
Best before: see bottle neck.
This bottle is intended for the exclusive use of Green Valley® spring water.
Keep cool and store in a clean dry place out of direct sunlight.
Green Valley
Spring Water
1.5 L
5 050432 000128
Typical analysis per litre: calcium 31mg, sodium 10mg, magnesium 7mg, potassium 7mg, nitrates 3mg, chlorides 20mg, sulphates 5mg, silica 8mg.
Twyni Spring is sourced in Wales in the Brecon Beacons: H8 Ltd, Blaen Twyni, Pen-Y-Cae, Swansea, SA9 1GS.

Store … out of direct sunlight!

or it might turn green?

India - Aqua-Fresh

India - Bada Bisleri

H2O'C
ENGINEERING

India - Free Bailley's

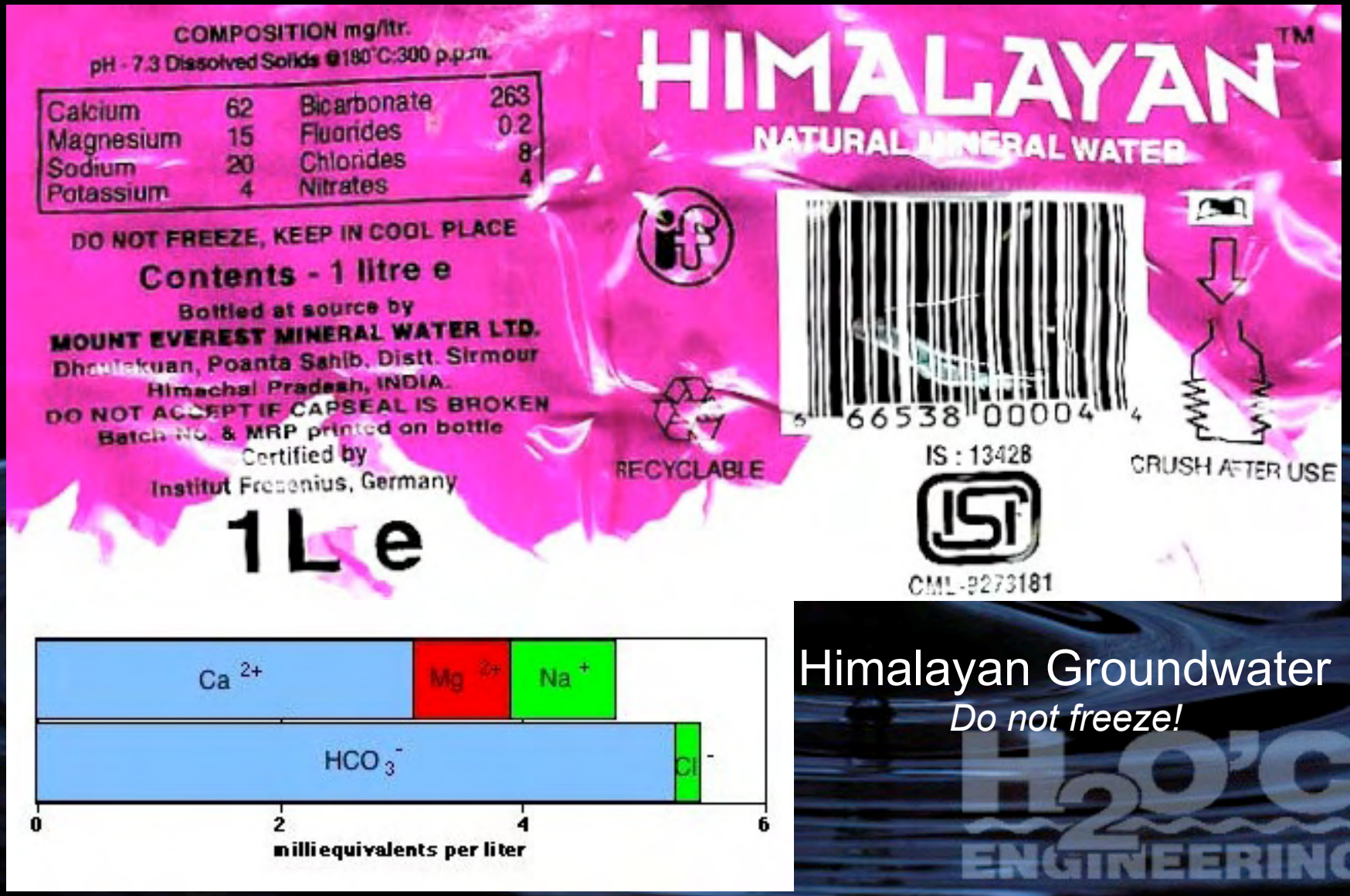
Do they put 1.2 liters into a 1 liter bottle?

Compressed water?

H2O'C ENGINEERING

India - Himalaya

Mount Everest Mineral Water



Himalayan Groundwater

Do not freeze!

H2O'C ENGINEERING

India - Oxyrich

Three times healthier?

Marketers apparently learned that application of ozonated oxygen to water results in increased oxygen concentrations.

H2O'C ENGINEERING

India - Sujal

I'm safe

Sujal
I'm safe
Quantity : 1 Litre net.
M.R.P. (Incl. of all taxes): Rs. 12
Bacth No. : 94
Date of Packing : DEC 03
Best for consumption within
Six months from date of packing
Process : Filteration, Reverse Osmosis,
UV Sterilzation, Micron Filteration & Ozonisation

After filtration, reverse osmosis membrane treatment, ultraviolet sterilization, micron filtration and ozonation, this product is deemed 'best' for *six months*.

H2O'C ENGINEERING

India - Urja

Text

No refills!

Please Crush the Bottle after Use

H2O'C ENGINEERING

Acqua in Italy

Mineral analyses **included on packaged water labels**

Temperature (at source?) recorded; warm for a groundwater.

No bottled water provides a measure of organic content

Vittel

Official Water

Le de Tour France

in 100% recyclable PET bottles

No analyses?
Hey, It's just water.

INTENSÉMENT PÉTILLANTE
SOURCE
BADOIT
SAINT GALMIER
1778
1L
Retrouvez Badoit Rouge au restaurant !
Avec son intense pétillance, Badoit Rouge bouscule les codes de la table en s'invitant au restaurant.
Elle y impose son style, son ton : ses bulles intenses vous réveillent les papilles et égayent votre repas. Pensez à la commander!
www.larevolutionatable.fr
Objectif 100%
Trions plus pour préserver l'environnement
Danone et vous
0810 11 12 13
H2O
Œuvres de la Collection Sandretto Re Rebaudengo
22 artistes internationaux contemporains confrontés au thème de l'eau.
12 juin-19 septembre 2010 Palais Lumière Evian
Tous les jours 10h30-19h (sauf le lundi 14h-19h) Rens. : +33(0)4 50 83 15 90 www.ville-evian.fr
Vittel
Official water
le Tour de France
Today in the UK, over 40% of plastic bottles are recycled.
100% target
Make sure you put this bottle in a recycling bin

English Carbonated Spring Water

appears to be a conventional ground water

while the

Florida True Spring Water Product

contains no Fat

CARBONATED
SPRING WATER
Bottled at source in the spa town of Harrogate, Harlow Moor Road, HG2 0GB
For best before end see neck
Store in a clean, cool, dry place away from sunlight, strong odours and chemicals
Sourced for Caffè Nero, 3 Neal Street, London WC2H 9PU
www.caffenero.com
CAFFÈ
NERO
SPRING WATER
Serve chilled
SPARKLING
Typical analysis (mg/l)
Calcium 52.7mg/l Ca
Magnesium 17.5mg/l Mg
Sodium 6.15mg/l Na
Fluoride 0.157mg/l F
Bicarbonate 235mg/l HCO3
Chloride 27.6mg/l Cl
Nitrate <1.0mg/l NO3
Sulphate 7.2mg/l SO4
pH at source 7.0
500ml e
water
FL OZ) 1 L
VASA SPRING WATER IS A TRUE SPRING WATER PRODUCT THAT IS NATURALLY SODIUM-FREE. BOTTLED BY CCDA WATERS, L.L.C., IN HIGH SPRINGS, FL 32643. SOURCE: GINNIE SPRING, GILCHRIST CTY., HIGH SPRINGS, FL. MICRONFILTERED AND OZONATED. CT #995, NYSHD Cert. #498, NV06868. FOR A REPORT WITH WATER QUALITY AND INFORMATION CALL 1-877-622-2897 OR WRITE: CCDA WATERS, L.L.C., INDUSTRY AND CONSUMER AFFAIRS, P.O. BOX 1734, ATLANTA, GA 30301. ENJOY!
©2009 CCDA WATERS, L.L.C.
DO NOT REUSE HI-ME-OR-CT 5¢
CA CRV
NSF
VASA®
V
natural spring water
sodium-free
33.8 FL OZ (1 QT 1.8 FL OZ) 1 L
Nutrition Facts
Serv. Size 8 fl oz (240 mL)
Servings Per Container about 4
Calories 0
Amount/Serving % DV*
Total Fat 0g 0%
Sodium 0mg 0%
Total Carb. 0g 0%
Protein 0g
Not a significant source of fat cal., sat. fat, trans fat, cholest., fiber, sugars, vitamin A, vitamin C, calcium and iron.
*Percent Daily Values (DV) are based on a 2,000 calorie diet.
CCDA WATERS, L.L.C.
ATLANTA, GA 30313
2009-1024
PROOF OF PURCHASE
1 L
F-530 07

Water Bottles:
Landfill & Litter

2.4 million metric tons of PET (polyethylene terepthalate), derived from crude oil, are used for bottles annually.

In the U.S., 86% goes to landfill or becomes litter.

U.S. consumes

1.5 million barrels of oil annually in production of disposable water bottles.

H2O'C ENGINEERING

U.S. PET Production - a plastic bubble?

North America's largest PET plant,

430,000 metric tons annually

projected to start-up in 2008 in Decatur, Alabama

Mossi and Ghisolfi Group plan

New 800,000 metric ton plant

somewhere in U.S.

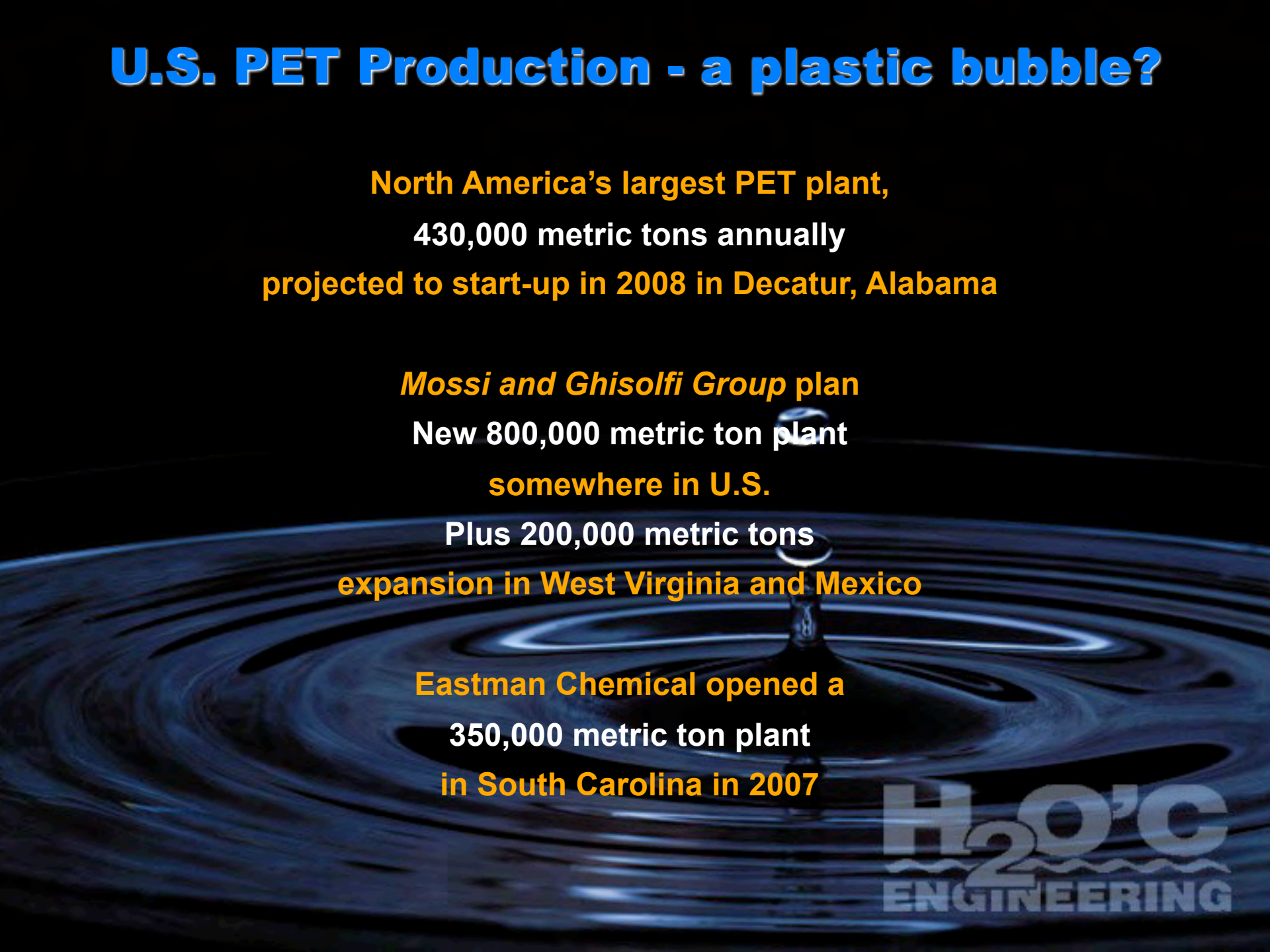
Plus 200,000 metric tons

expansion in West Virginia and Mexico

Eastman Chemical opened a

350,000 metric ton plant

in South Carolina in 2007



San Francisco

"No City Purchase of Bottled Water!"

"City ban will help stem global warming, save taxpayer money"

Environmental impact of making, hauling, disposing of bottles

Over a billion bottles end up in California's landfills each year

H2O'C ENGINEERING

2007 Chez Panisse

Berkeley, California

stopped serving bottled water
citing environmental impacts

The Bottled Water *BS Alarm*

has also gone off in:

San Francisco	Seattle
Los Angeles	Minneapolis
Salt Lake City	New York City
Ann Arbor	Boston
St. Louis	Santa Barbara
Berkeley	San Leandro, …

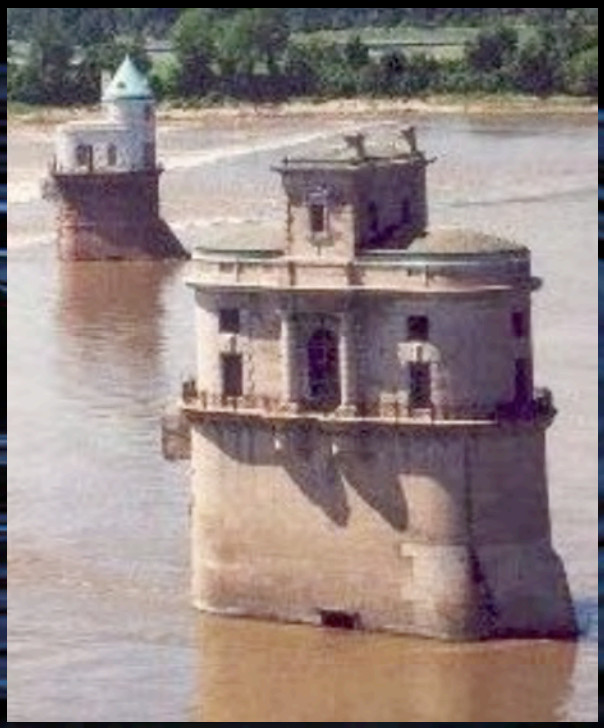
H2O'C ENGINEERING

City of St. Louis

Starting this spring, City Hall will no longer buy bottled water for employees and plans to cancel the roughly $20,000 it has in contracts with area vendors.

St. Louis sells treated Missouri River drinking water to PepsiCo's north St. Louis facility, which filters it again and sells it as *Aquafina* for $1.25 a bottle.

ext



Swiss Researchers calculate Environmental Costs of Tap vs. Bottled Waters

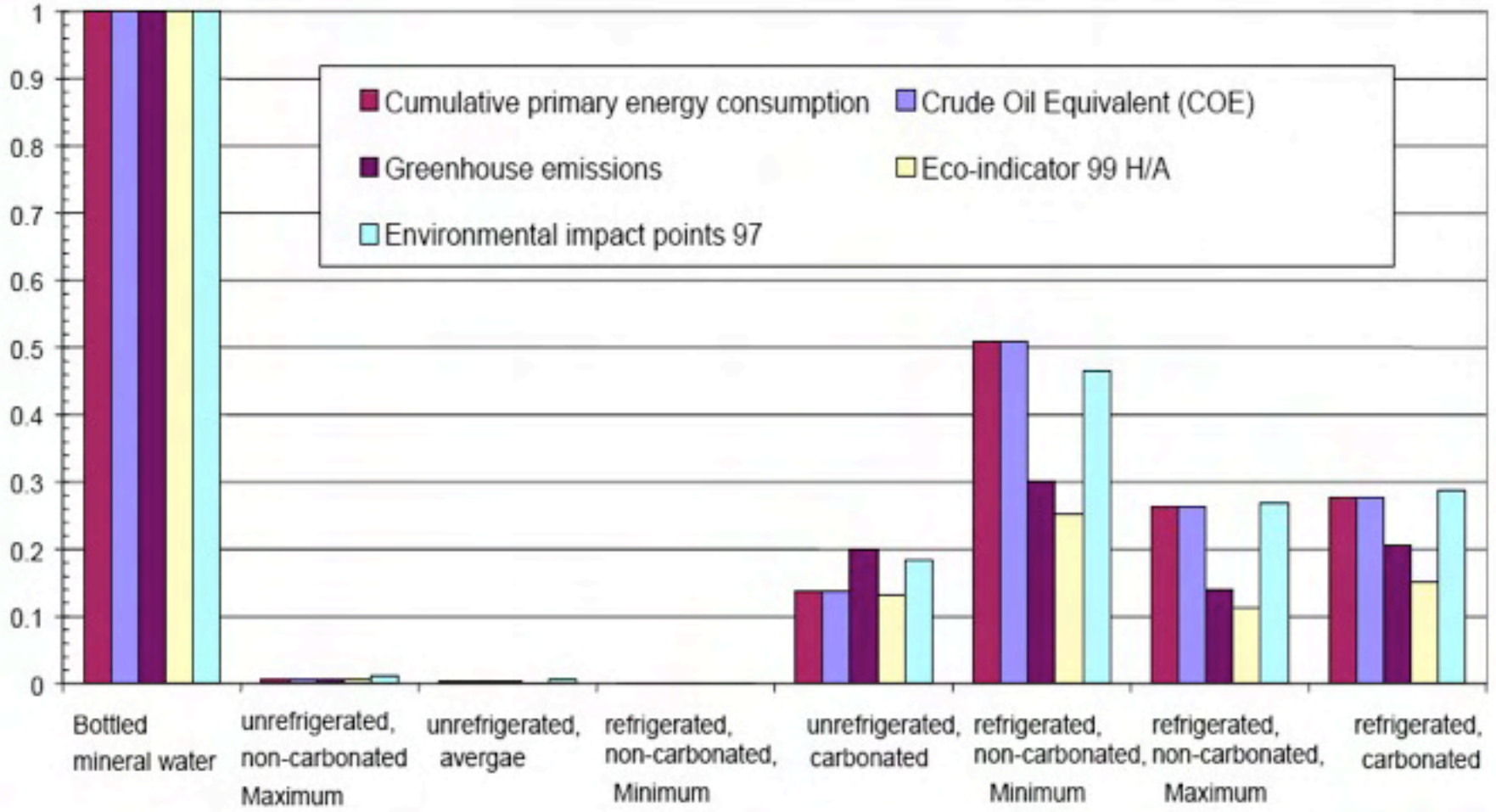


Fig. 4.2 Relative Comparison of the Environmental Impact of Bottled Mineral Water vs. Tap Water. The height of the bar indicates the environmental impact of the tap water variants as compared to the corresponding variant for bottled mineral water.

Arguments re: Bottled Water

Aficionado	Cynic
I can taste the difference!	Ever tried a taste test?
I am sensitive!	Can you smell plastic?
It is better for you than soda pop!	So is tap water!
You can recycle the plastic!	Americans don't recycle!
I want to protect my family's health!	From what? (Do you know what is in the bottled water?)
It's convenient!	How hard is it to fill a bottle from the tap?

H2o'C ENGINEERING

TheWaterProject.org

Skip the Bottle, Save a Life

Asks *"What's 'wrong' with bottled water?"*

'Bottled Water is a Luxury In the face of the needs of real people, suffering the real effects of water scarcity, luxury should not be our choice.

'Bottled Water is Wasteful Most luxuries are, but bottled water has *enormous* costs that rival some of the biggest offenders.

'The Money Spent Can Be Used Better Elsewhere Waste not, and others will want less. Your resources can change someone's life!

H2O'C ENGINEERING

Lighterfootstep.com

lists five reasons not to drink bottled water

- Bottled water isn't a good value
- It is no healthier than tap water
- Bottled water creates trash, litter, landfill
- Bottled water means less attention to public systems
- Leads to the corporatization of water

H2O'C ENGINEERING

Fiji Water - 'distant and exotic'

Manufacture of a 1 kilogram bottle requires:

6.7 kilograms of water and

0.85 kilograms of fossil fuel

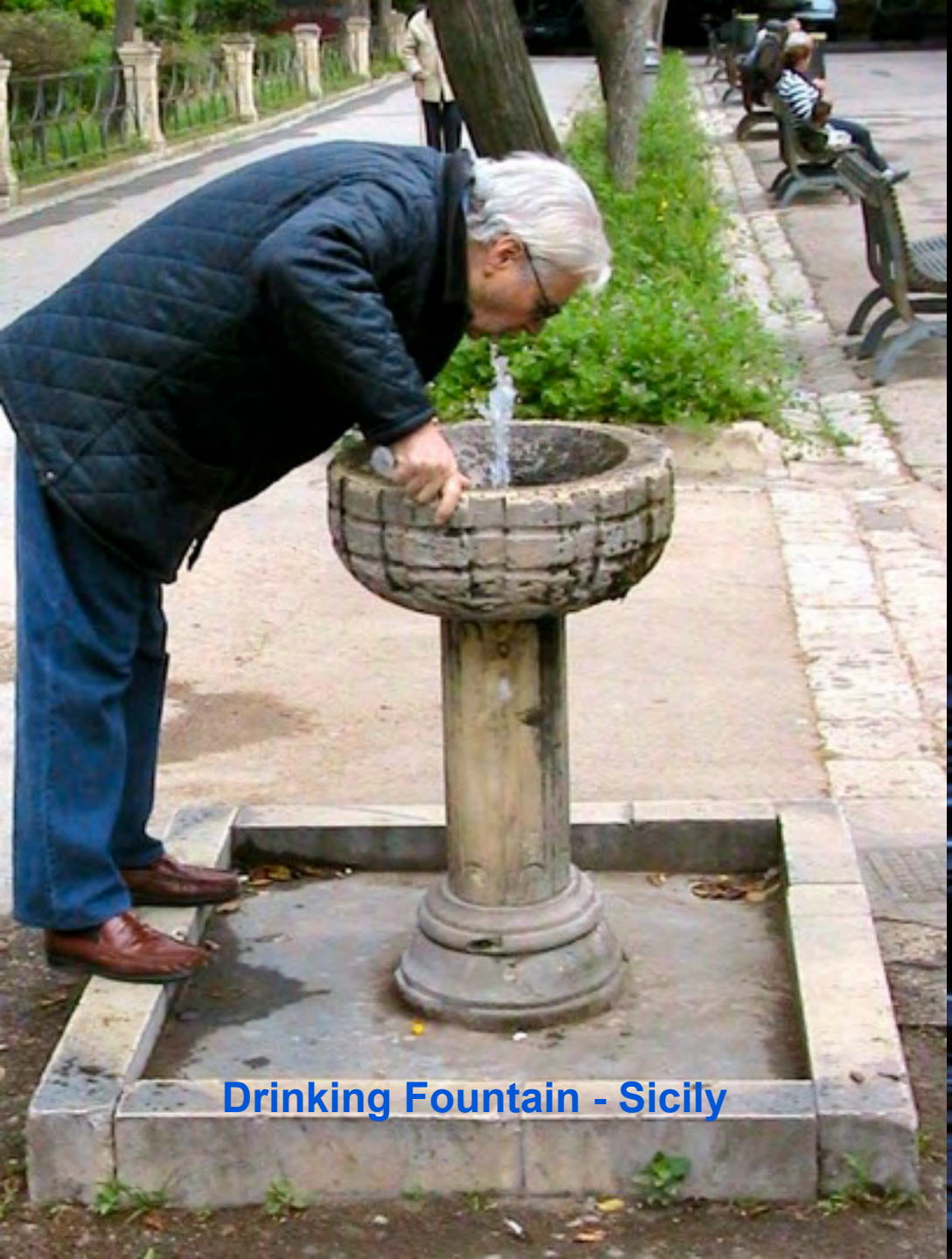
Shipment (8700 km) to U.S. results in:

0.56 kilogram of emissions

Retail Cost: $1.50

After Evian, Fiji is #2 in premium bottled water

FIJI
Untouched by man.
Until you drink it.
FIJI Water comes from an aquifer deep within the earth on the remote islands of Fiji. Bottled at the source, natural
through a hermetically sealed delivery
exposed to the environment. At least,
until you unscrew the cap.
www.fijiwater.com
Typical Analysis in mg/liter:
Silica 85
Calcium 17
Magnesium 13
pH 7.5
Bicarbonates 140
Total Dissolved Solids 210
Source: Yaqara, Viti Levu, Fiji Islands. Bottled by:
1 Naseyani Rd, Yaqara, Fiji
PRODUCT OF FIJI
Please Recycle
1.877.426.3454
500 mL (1.05 PT)
6 32565 00001 2



Drinking Fountain - Sicily

Are Water Fountains an Anachronism?

In 2007, the **University of Central Florida** hosted a home game in their new $54 million football stadium. Ignoring building codes, the stadium had been constructed without water fountains.

More than sixty people were treated for heat exhaustion.

H2O'C ENGINEERING

IBWA Decries Bottled Water 'Activism'

"During the past year, critics of bottled water have become more organized and active, instituting new methods and tactics to attack the industry."

Corporate Accountability International (CAI)

"…even acknowledges … the support it had from a number of faith-based organizations …"

"They are exploiting the current political climate that supports environmental issues to demonize the bottled water industry."

"… arm yourself with the facts at www.bottledwater.org"

H2O'C ENGINEERING

International Bottled Water Association

Cites bottled water consumers' fears:

- aging municipal distribution systems,
- health issues related to the use of chlorine / chloramine,
- taste of chlorine,
- fear of contamination from chemical spills, organics, sabotage
- health concerns about consumption of soft drinks.

International Bottled Water Association

IBWA is now

Pro-choice:

bottled water is about beverage choice

Pro-Environmental:

recycling must focus on all packaging

International Bottled Water Association

IBWA is:

- ✓ launching a comprehensive ad campaign to respond to the growing threat from activist groups
- ✓ members are urged to stay alert to critics, misinformation
- ✓ developing solid relationships with community leaders and elected officials
- ✓ to counter the misinformation that activists may offer, go to:

www.bottledwater.org

H2O'C ENGINEERING

IBWA Turns 'Green' - 2008

Nestlé

- will use 30% lighter plastic bottles
- will use 30% smaller labels; *Eco-Shaped* bottles
- bottles will be 100% recyclable and more *compactable*
- is building plants that are *green-building certified*
- will use trucks that are well-maintained, more efficient
- is looking at hybrid forms of transportation

IBWA

- joined the *National Recycling Partnership*
- will lobby govt. officials to get *efficient* recycling programs
- took full-page ads: NY Times, SF Chronicle

H2O'C ENGINEERING

IBWA Turns 'Green' - 2008

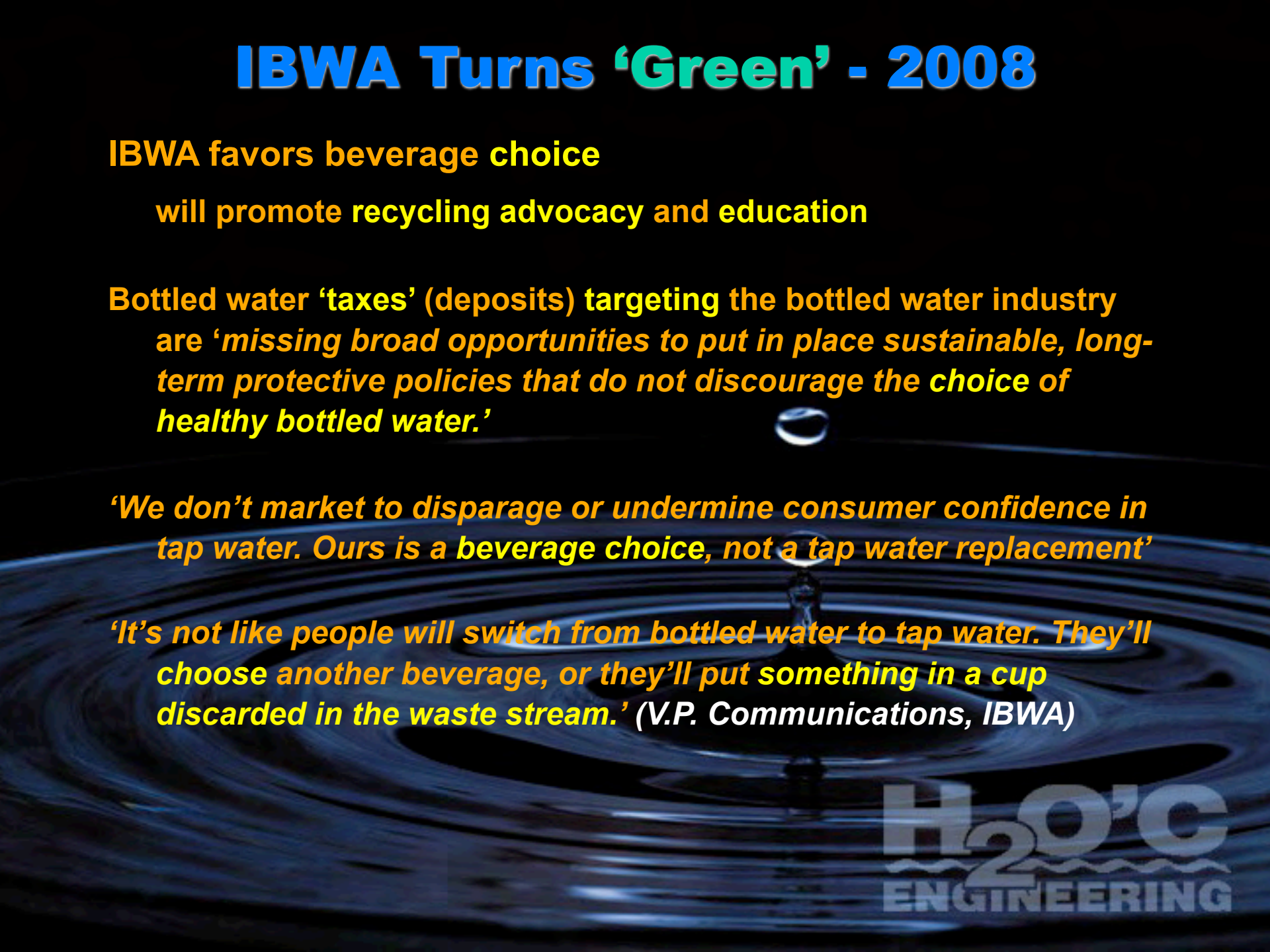
IBWA favors beverage choice

will promote recycling advocacy and education

Bottled water 'taxes' (deposits) targeting the bottled water industry are '*missing broad opportunities to put in place sustainable, long-term protective policies that do not discourage the choice of healthy bottled water.*'

'We don't market to disparage or undermine consumer confidence in tap water. Ours is a beverage choice, not a tap water replacement'

'It's not like people will switch from bottled water to tap water. They'll choose another beverage, or they'll put something in a cup discarded in the waste stream.' (V.P. Communications, IBWA)



Recycle your PET?

Coca-Cola reacts to critics

will build world's largest PET recycling plant,

100 million lbs/year, in Spartanburg, S.C.

45,000 metric tons

Coke claims markets in 200 countries

Goal

to recycle 100% of its U.S. PET bottles

How? --- by establishing

recycling centers throughout the U.S.

promoting *curbside collection* of PET

H2O'C ENGINEERING

rPET

PET bottles that get recycled *(and >70% don't)* are first pulverized and rinsed.

Caps and labels are then separated from the mix.

PET flakes are then heat-treated to reduce contaminants.

In addition to the energy initially used in the manufacture of the virgin PET, recycling adds the costs of material recovery and reprocessing to the environmental burden created by bottling water.

20'C ENGINEERING

Plastics Recycling Rates Decline in U.S.

"Plastics don't actually recycle.

Instead, they are reprocessed into secondary (usually non-recyclable) products due to their structural/chemical sensitivity, the extremely low cost of virgin plastics, poor product design and materials policy." International Plastics Task Force

Despite curbside recycling, the
PET recycle rate dropped to 11-year low of 22% in 2001.

With the discard of contaminated material, the
PET utilization rate was 18%.

H2O'C ENGINEERING

Recycling is Significant Burden Shifted to Municipalities

"The city's recycling program will be drastically scaled back starting today, as the Bloomberg administration, in a money-saving move, halts the recycling of glass and plastics."

New York Times, July 1, 2002

It takes about 3-5 times the number of personnel

to recycle as to landfill.

U. S. Conference of Mayors - 2008

considers resolution on purchase of bottled water

SUPPORTING MUNICIPAL WATER SYSTEMS

WHEREAS, the United States' municipal water systems are among the finest in the world; and

WHEREAS, high quality, safe drinking water is already available at most public locations; and

WHEREAS, mayors are responsible for delivering safe and affordable water to our citizens; and

WHEREAS, bottled water is regulated by the FDA and municipal tap water is regulated by the EPA and has more stringent requirements for testing; and …

H2O'C ENGINEERING

U. S. Conference of Mayors - 2008

WHEREAS, local governments invest approximately $82 billion a year to provide water and sewer services; and

WHEREAS, bottled water often costs more than an equivalent volume of gasoline, equivalent to 1,000 to 10,000 times more than tap water; and

WHEREAS, up to 40% of bottled water on the market comes from municipal water systems and the bottled water industry generated $15 billion in revenues in 2006 from U.S. consumers; and

WHEREAS, bottled water often travels many miles from the source, resulting in the burning of massive amounts of fossil fuels, releasing CO_2 and other pollution into the atmosphere; and

WHEREAS, plastic water bottles are one of the fastest growing sources of municipal waste; and …

H2O'C ENGINEERING

U. S. Conference of Mayors - 2008

WHEREAS, in the U.S. the production of plastic bottles for bottled water currently requires the energy equivalent of more than 17 million barrels of oil per year – enough to generate fuel for over a million cars for a year – and generates more than 2.5 million tons of carbon dioxide; and

WHEREAS, we applaud the US Conference of Mayors for its National City Water Taste Test, which recognizes all of the great work municipal water systems do for its residents on a daily basis, year after year; and

WHEREAS, the US Conference of Mayors, per Resolution #90 adopted in June 2007, has compiled much information regarding the importance of municipal water and the impact of bottled water on municipal waste.

WHEREAS, the evidence suggests that banning bottled water from government use highlights the importance of municipal water and decreases the impact of bottled water on municipal waste.

H2O'C ENGINEERING

U. S. Conference of Mayors - 2008

NOW, THEREFORE, BE IT RESOLVED, that the US Conference of Mayors encourages cities to phase out, where feasible, government use of bottled water and promote the importance of municipal water.

Resolution 70 Submitted by:

The Honorable Gavin Newsom
Mayor of San Francisco

The Honorable Michael Bloomberg
Mayor of New York City

The Honorable Thomas Menino
Mayor of Boston

The Honorable Laurel Lunt Prussing
Mayor of Urbana

The Honorable Martin Chavez
Mayor of Albuquerque

The Honorable Dan Coody
Mayor of Fayetteville

The Honorable Will Wynn
Mayor of Austin

The Honorable R.T. Rybak
Mayor of Minneapolis

The Honorable David Cicilline
Mayor of Providence

The Honorable Joseph A. Curtatone
Mayor of Somerville

The Honorable David Cicilline
Mayor of Providence

The Honorable Richard M. Daley
Mayor of Chicago

The Honorable Marty Blum
Mayor of Santa Barbara

The Honorable Michael Nutter
Mayor of Philadelphia

The Honorable Manuel Diaz
Mayor of Miami

H2O'C ENGINEERING

BPA in Baby Bottles

March 6, 2009 - San Francisco Chronicle:

... six major companies have agreed to stop selling hard-plastic baby bottles containing bisphenol A, an industrial chemical suspected of harming human development ...

... some of the companies have been making bisphenol A-free alternatives, including old-fashioned glass baby bottles ...

Studies in lab animals indicate that even small amounts of bisphenol A can damage brain and reproductive systems, alter mammary and prostate glands and lead to heart disease, obesity and diabetes.

H2O'C ENGINEERING

Leaching from Plastic Bottles ?

- Mineral water packaged in plastic contains roughly twice the amount of estrogen mimics compared with water sold in glass ...
- Estrogenic compounds have potential adverse health effects ...
- Increased activity in 12 of 20, most of which relied on PET bottles
- Female snails, raised in PET bottles, produced more than double the number of embryos compared with snails raised in glass bottles.

Environ. Sci. Poll. Research, DOI: 10.1007/s11356-009-0107-7

H2O'C ENGINEERING

Why is Tap Water Safer?

Public Water Supplies subject to USEPA regulations: 83 MCL parameters

Bottled water (a Food Product) is regulated by the Food and Drug Admin.

FDA sets Standards of Quality (SOQ) for food products; weak for water.

Operationally, bottlers may test for only a few quality parameters:

e.g., coliform bacteria, ozone residual, conductivity, pH, fluoride

Tap Water is fresh, maintains a disinfectant residual, and has not been in contact with untested and unapproved surfaces, such as Bisphenol A.

H2O'C ENGINEERING

Bottled Water Insanity Pandemic - 2008

Better than milk for babies!

Saphia Water - *'designed'* by a neonatologist in consultation with lactation experts, will be offered in Lovingly Lemon, Pacifying Peach and Bliss Berry flavors at Babies R Us and Motherhood Maternity Stores.

H2O'C ENGINEERING

Saphia™ Water for Smart Women Expecting More

***Saphia Water** is the first enhanced water created specifically to respond to obstetricians' universal prescription for pregnant women and breastfeeding mothers to drink the equivalent of at least eight, eight-ounce glasses of healthy water daily.*

At $45/case, that's $1,832 for 9 months

How far would you go for Love?
This bottle has been individually hand crafted with Swarovski Crystals making it unique in the Love Limited Edition Collection
Luxury in a bottle.
www.LoveH2o.co.uk
Love
Limited Edition
£21.99
Each Country of origin England
H2O

£ove = £ 21.99

is all you need ...?

Bottled Water Insanity Pandemic - 2008

When your water sommelier brings you a **Swarovski crystal-studded bottle**, it will contain **Bling h²o**, the most expensive water in the world.

Offered for an exclusive market *'where water is the new wine'*, this $38 per bottle potable is reputedly Paris Hilton's choice for her Chihuahua.

Your on-line price for the limited edition 'Christmas' Bling (750 ml in a crimson and Peridot green bottle) is $40.

Bling h²o is also available in

'convenient' plastic bottles.

H2O'C ENGINEERING

home
pretty face
pretty taste
contact
store
bling h2O
IN THE NEWS: Most Expensive Bottled Water
Fancy water that's costlier than wine. A few months ago, Madonna's pal let it slip that the Material Girlfriend spends $5000 each month for water blessed by Kabbalah rabbis.
BLING NOW!
Look Who's Talking
FOX

$55 per bottle - girl not included

Water Babies

Let's Review the Effect of Evian on your Body

http://www.youtube.com/watch?v=Z1xPPHNZU5I

Bring your Own Bottle?

Eliminate Bottle Transport & Waste

*The **Boomerang Water Bottling System,** if ever deployed near you, promises to "sanitize, fill and cap glass and aluminum bottles of water on site for immediate sale and consumption, thereby eliminating landfill contribution and reducing CO_2 emissions."*

H2O'C ENGINEERING

Nutritious Carbohydrates:
50 kilocalories per serving,
2.5 servings per bottle

Vitaminwater
(hydrate responsibly)

World of Coca-Cola

GLACÉAU vitaminwater

formula 50

50% daily dose

provides 50% of the many important vitamins you need every day (b vitamins, c, e + folic acid).

formula 50

grape

ingredients: vapor distilled/deionized water, crystalline fructose, natural flavor, citric acid, ascorbic acid (Vitamin C), vitamin E acetate, fruit and vegetable juice (color), magnesium lactate (electrolyte), calcium lactate (electrolyte), niacin (B3), monopotassium phosphate (electrolyte), pantothenic acid (B5), pyridoxine hydrochloride (B6), cyanocobalamin (B12), folic acid.

make your drink work for you.

PHYSICIAN DEVELOPED

Protect your skin from the inside out.

Boost your memory and mental acuity with powerful antioxidants.

Help rid your lungs and sinuses of airborne pollutants and fight hangovers.

Ease sore muscles and hydrate after working out.

All-natural time release energy and stamina for 6-8 hours.

Help boost your immune system and fight colds.

Improve your mood and reduce stress.

Ignite your metabolism and burn more calories per hour.

Nutrition Facts
Serving Size 8 fl oz (240 mL)
Servings Per Container 2.5

Amount Per Serving	
Calories 50	
	% Daily Values*
Total Fat 0g	0%
Sodium 0mg	0%
Total Carbohydrate 13g	4%
Sugar 13g	
Protein 0g	

	per serving	per bottle
Vitamin C	20%	50%
Vitamin E	20%	50%
Vitamin B3	20%	50%
Vitamin B6	20%	50%
Folic Acid	20%	50%
Vitamin B12	20%	50%
Vitamin B5	20%	50%

*Percent Daily Values are based on a 2,000 calorie diet.
contains less then 1% juice
not a significant source of calories from saturated fat, cholesterol, dietary fiber, vitamin A, calcium or iron

No! The calories are from 32.5 g of sugar!

Propel Fitness Water

Now, with high fructose corn syrup!

Still, Propel contains less sugar, salt, and carbohydrates than its cousin, Gatorade, which offers 50 kilocalories per 240 ml serving.

One sports drink, notably Gatorade, even comes without *water*. It is also sold as a powder.

FortiFido or PET SWEAT ?

Vitamin Water in PET for your PET

HEALTHY BONES

(Peanut Butter Flavored) With Calcium added to help maintain healthy bones in **adult dogs.** Available in two sizes: 1 liter and 2 liter.

GUARANTEED ANALYSIS	
Moisture (max)	99.9%
Calcium	0.02%
Pantothenic acid (Vitamin B5) (min)	5 MG/KG
Niacin (Vitamin B3) (min)	10 MG/KG
Vitamin B6 (Pyridoxine) (min)	1 MG/KG
Vitamin B12 (min)	0.015 MG/KG

Bottled Water Insanity Pandemic - 2011

MaMaMiO

from Kraft to their friends on Facebook

'A liquid water enhancer'

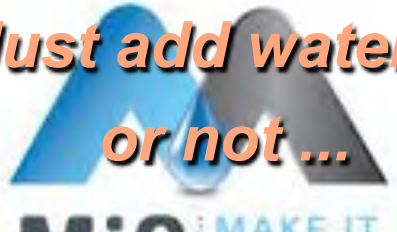
'because stuff is better when its yours'

'Add a little. Or a lot.'

'Whatever works for you.'

Just add water ...

or not ...



Ingredients (Mango Peach):
Malic Acid, Propylene Glycol, Citric Acid, <2% Natural Flavor, Sucralose, Acesulfame Potassium, Potassium Citrate, Polysorbate 60, Yellow 5, Yellow 6, Red 40, Potassium Sorbate.

'Caffeine-free', 'sugar-free'

H2O'C ENGINEERING

Bottled Water Insanity Pandemic

Sensing a challenge, H_2O'C Engineering is in the process of developing a highly advanced water product having the potential to sell for even more than all other competitors.

Condensed in hydrostatically-fused borosilicate capillaries,

H_3O'C bi-ionic electroneutral polywater

promises to be a *powerdrink* capable of delivering steroids and male enhancement products in undetectable form.

In addition to saving marriages, *polywater* has already shown its capability for curing cancer and minimizing the effects of the common cold.

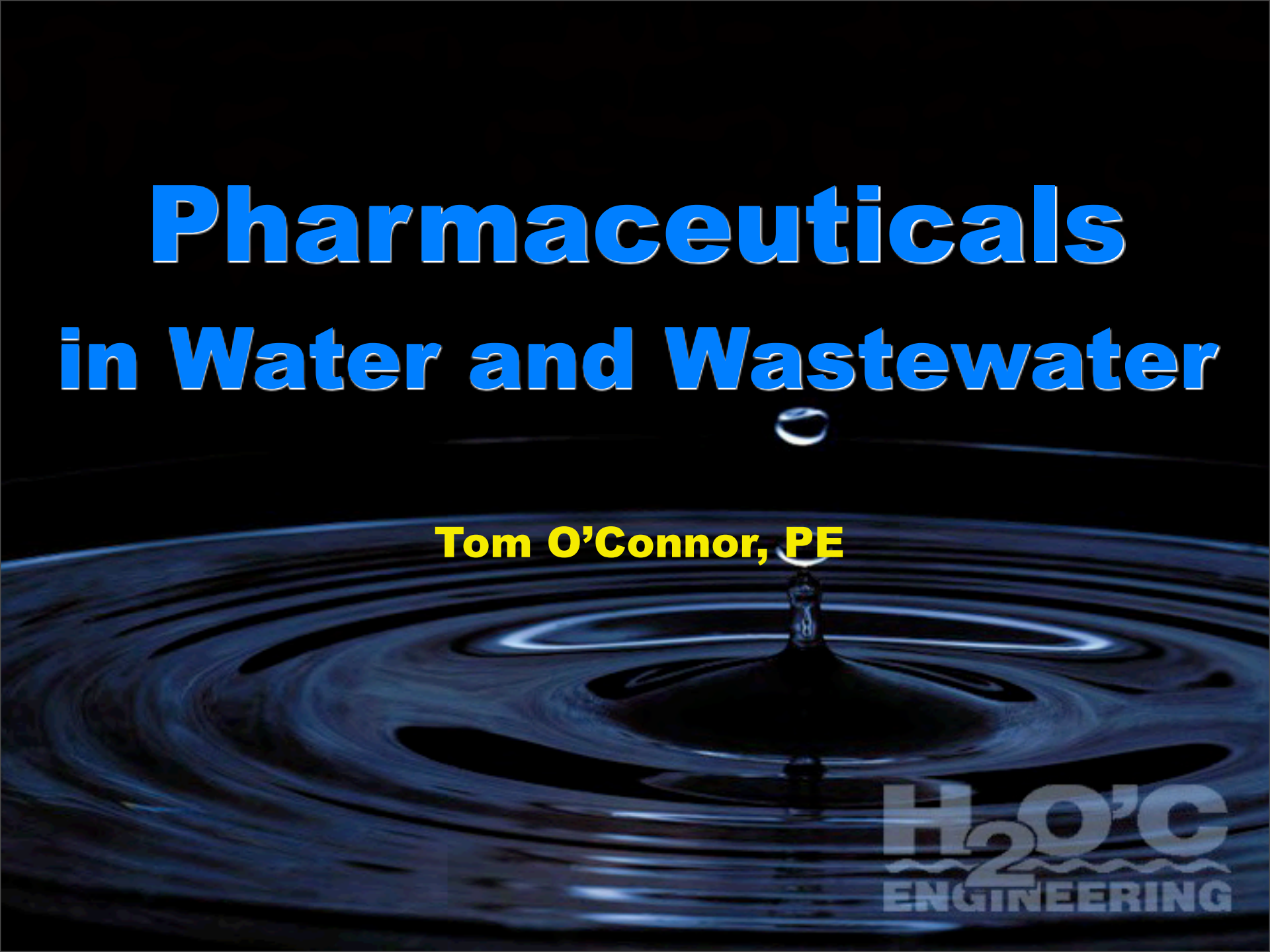
What's in it? Don't ask; we won't tell.

But, if you *really* love your family ... !

H2O'C ENGINEERING

Pharmaceuticals in Water and Wastewater

Tom O'Connor, PE



Emerging Health Concerns

pharmaceuticals: N-nitrosodimethylamine (NDMA), 1,4-dioxane, bisphenol A, alkylphenol polyethoxy carboxylates (APECs), dioxin, disinfection by-products, ...

cosmetics, hormones, nanomaterials

endocrine disruptors, a class of compounds that perturb the normal functioning of endocrine systems including those that affect growth, reproduction and behavior.

Partial removal requires capital, energy-intensive processes:

(GAC adsorption; ozonation; micro-, ultra-, nano-filtration; reverse osmosis; membrane bioreactors; advanced oxidation (hydrogen peroxide - UV)

H2O'C ENGINEERING

Pharmaceuticals in drinking water

* In Virginia Beach, pharmaceuticals were found in source water but not in treated drinking water.

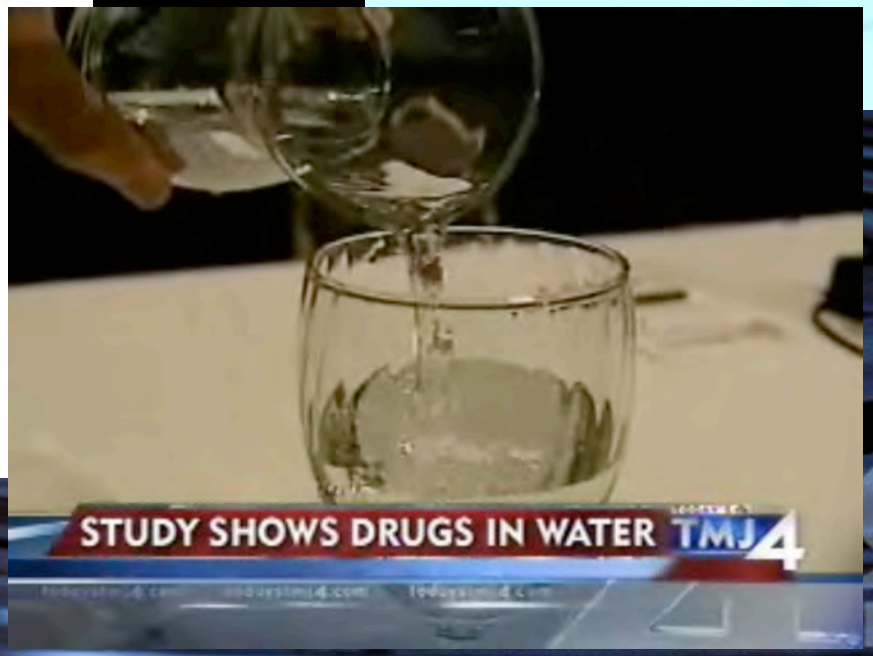
** Drinking water in Austin, Texas, was tested for only one prescription drug, a synthetic birth control chemical.

NOTE: All places include some surrounding areas except: Albuquerque, N.M.; Arlington, Texas; Fresno, Calif.; Long Beach, Calif.; Los Angeles; Memphis, Tenn.; New Orleans; New York City; and Orlando, Fla.

SOURCES: Drinking water providers' responses to Associated Press questions; AP review of scientific literature.

AP

Great Headlines



Over-the-Counter Drugs in Drinking Water

Caffeine was found at the highest concentration of all drugs tested by Philadelphia Water

If you drink eight glasses of water a day for more than 1,200 years, you'll get the amount of caffeine in a single cup of coffee (~100 mg)

Over-the-Counter Drugs in Drinking Water

If you drink eight glasses of water a day for more than 40,000 years, you'll get the amount of acetaminophen in a single infant dose (80 mg) of Tylenol.

There is currently no indication that such extremely low concentrations pose any public health risk.

H2OC ENGINEERING

Recreational Drugs in Wastewater

Oregon State University drug-tested influent at 40 wastewater plants:

- A *"city with a gambling industry"* used five times more methamphetamines
- A *"fairly affluent community"* scored low for everything except cocaine
- Cocaine and ecstasy levels peaked on the weekends,

  but the meth and prescription drugs were constant

H2O'C ENGINEERING

Pharmaceuticals

"Ask your doctor if _____ is right for you"…
take pills ⇒ pee 'em out (& dispose extras) ⇒ toilet ⇒ wastewater plant ⇒ river ⇒ drinking water treatment plant intake ⇒ tap

Concentrations in drinking water are in the parts-per-bazillion range.

The real story here is:

- ✓ How amazing the detection methods of modern analytical equipment are.
- ✓ This stuff that we make persists and is incorporated into the environment.

H2O'C ENGINEERING

Refrigerator 'Filters'

Dr. John T. O'Connor, PE

Tom O'Connor, PE

Section 1

My Kichen Tap versus my Refrigerator ‘Filter’

‘FILTERED’ WATER?

1. **This investigation was conducted in 2007 and posted to the *H_2O’C Engineering* website in 2008: http://www.h2oc.com/h2oc-library/libraryindex.html**
2. **The slide show was posted to the American Chemical Society website, January, 2011 under *Water and Wastewater Slide Shows*: https://communities.acs.org/blogs/h2oc?start=15**

Since refrigerators often come with houses and last for decades, it can be a major household event when a truly brand new unit arrives. When this finally occurred, the opportunity to compare the water issuing from our new filtered water dispenser with our local tap water was irresistible.

What kind of *‘filter’* adds particles (e.g., microorganisms) to water?

Although the microorganisms appeared more rapidly than expected, the presence of bacteria in the water dispensed by my new refrigerator was predictable. It is well-known that carbon, a reducing agent, readily consumes chlorine. It is this absence of chlorine that consumers cite as their perception that the water quality (taste) has improved. In the absence of a disinfectant residual, however, bacterial growth will occur.

The only question was, *“How quickly?”*

Kitchen

Refrigerator Dispenser - Ice and Water

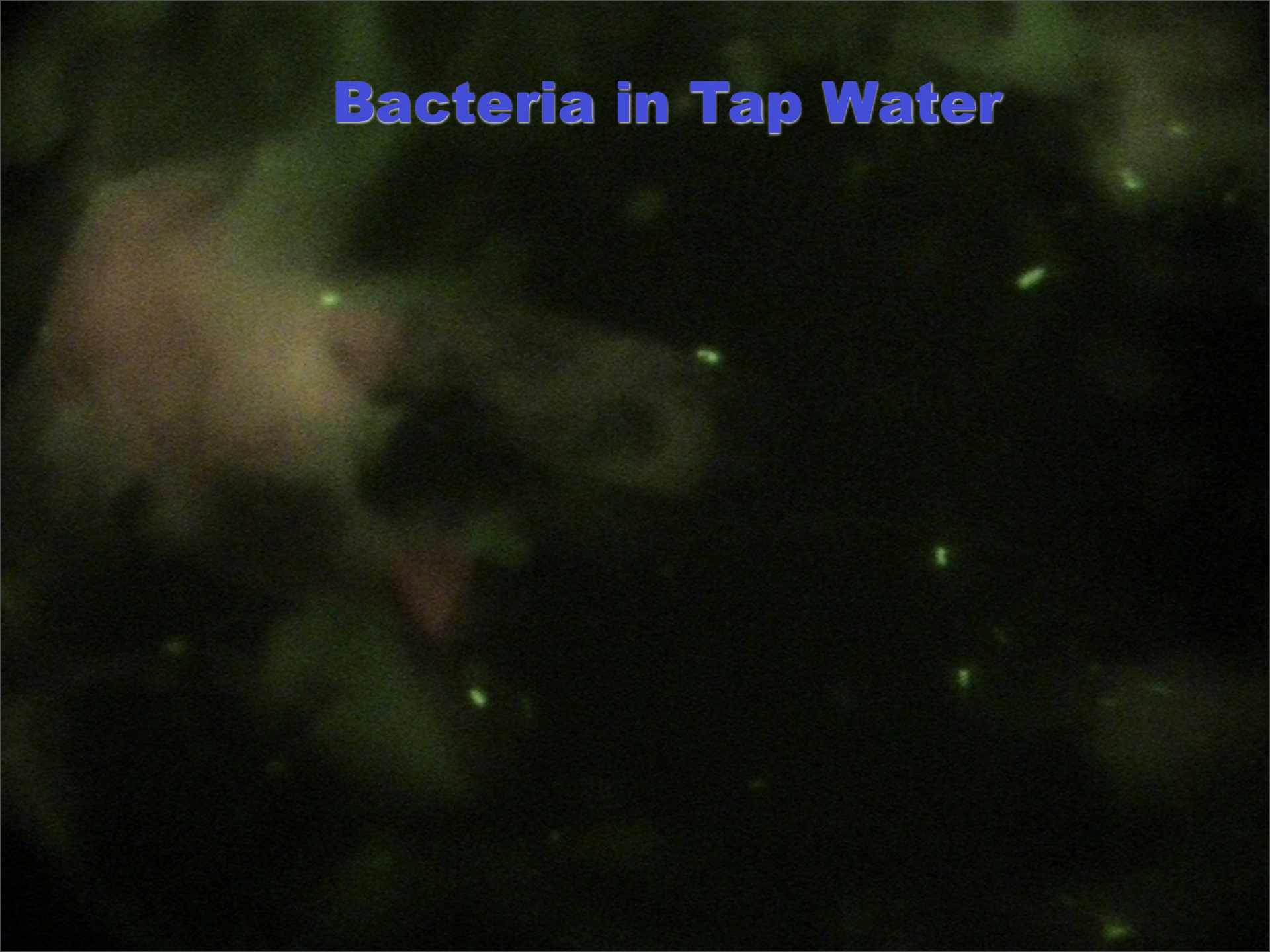
Ice

Municipal Tap Water
Columbia, MO

Bacteria in Tap Water

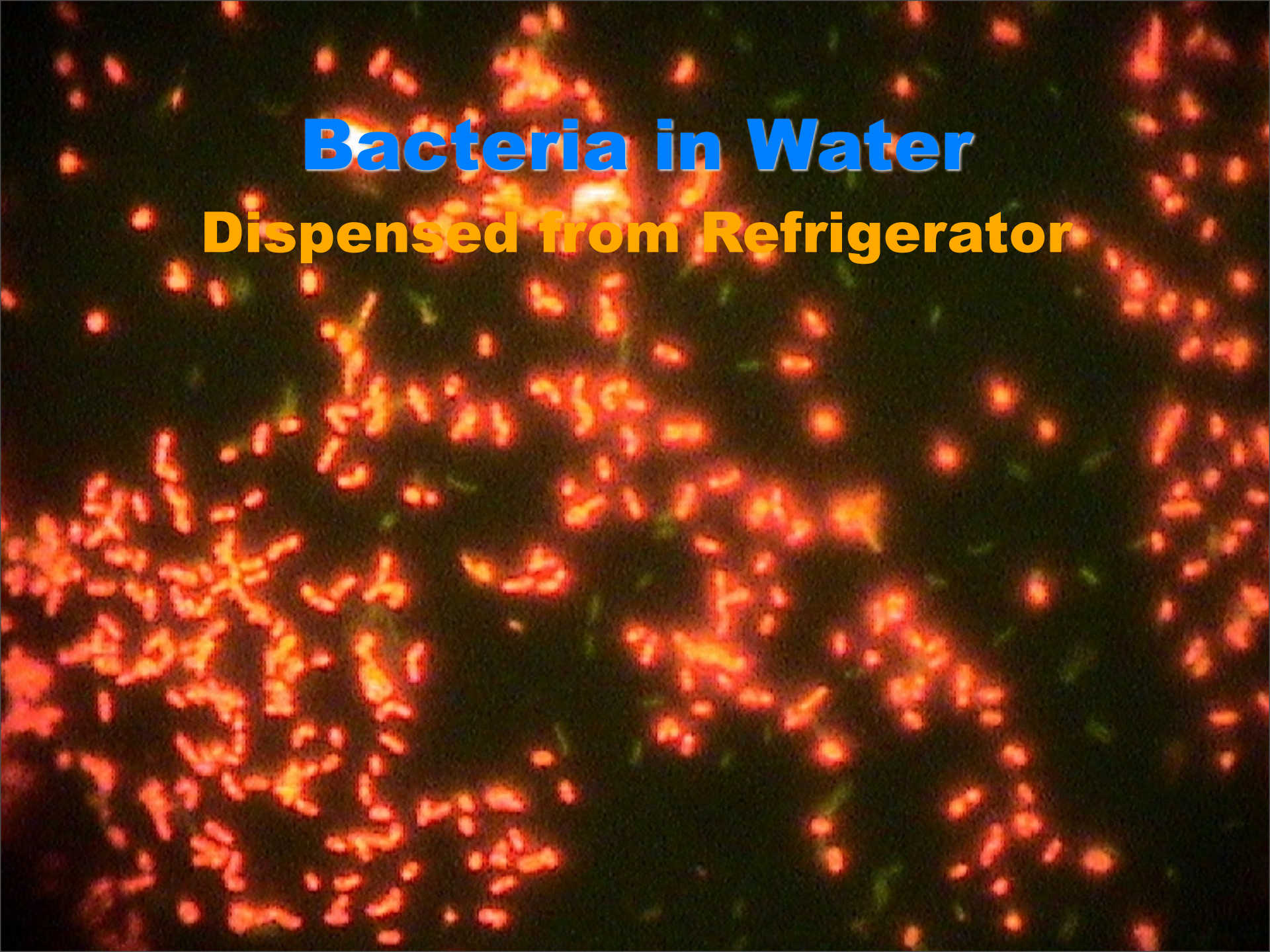
Bacteria in Tap Water

Bacteria in Tap Water

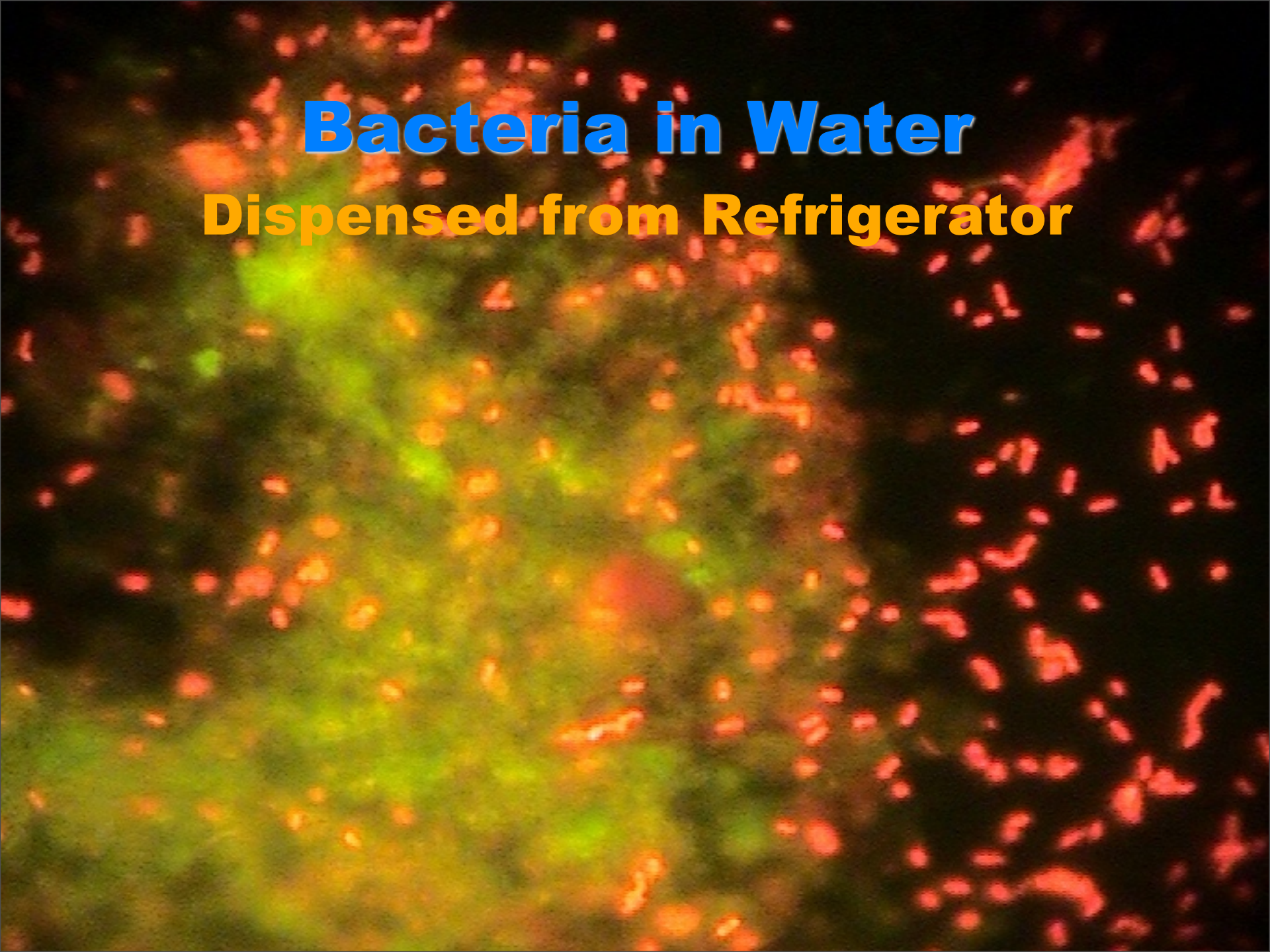


Bacteria in GAC Filtered Water
Dispensed from Refrigerator
Some cells
are dividing

Bacteria in Water
Dispensed from Refrigerator


Bacteria in Water
Dispensed from Refrigerator

Bacteria in Water
Dispensed from Refrigerator

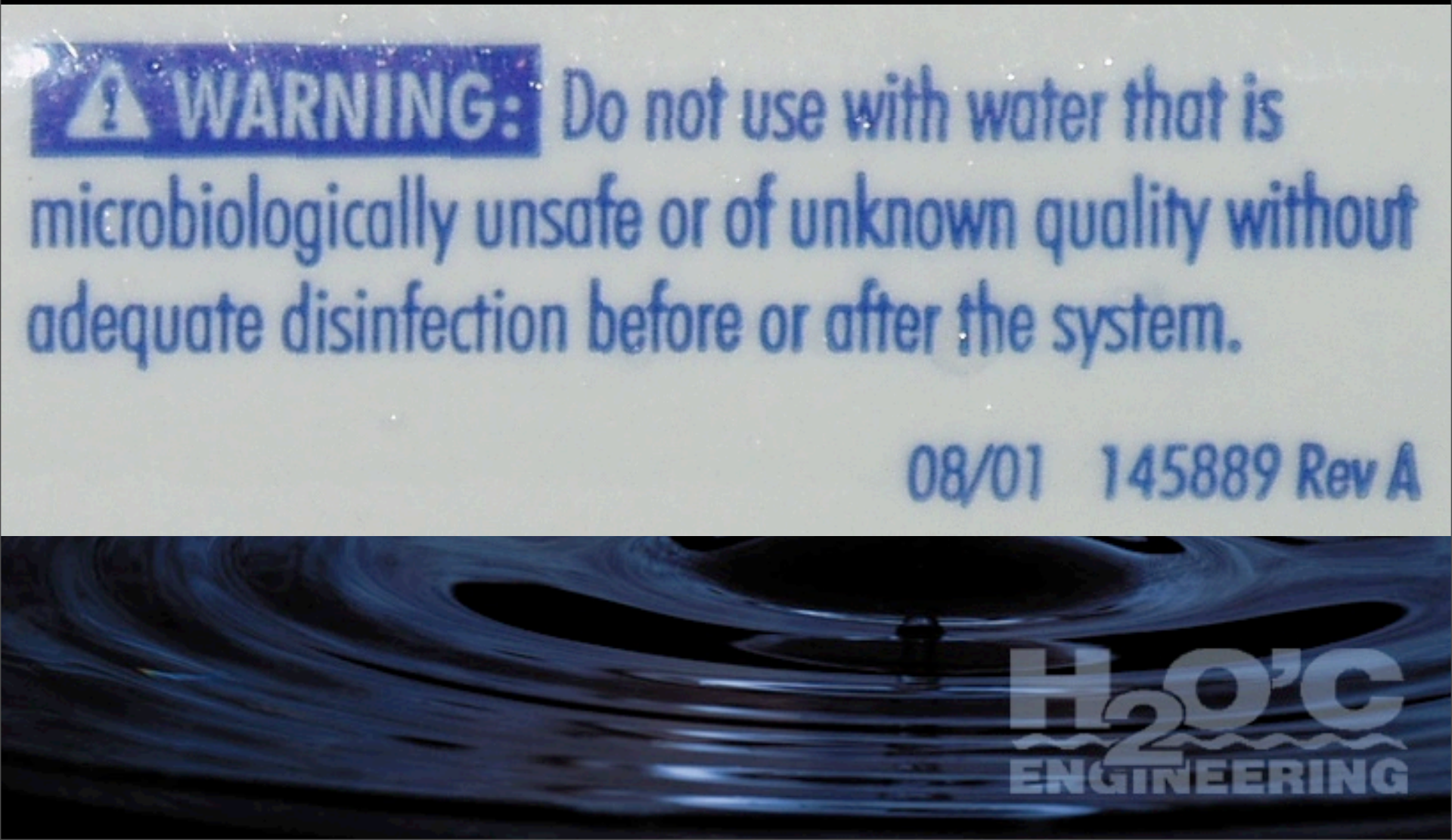

Bacteria in Water
Dispensed from Refrigerator

Bacteria in Melted Ice

Dispensed from Refrigerator

Refrigerator Filters

Water Filter Label Warning


WARNING: Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system.
08/01 145889 Rev A
H2O'C
ENGINEERING

Kenmore®

FILTERED BY / UTILISE LE FILTRE

For replacement filters visit your local SEARS® store o
call 1-800-469-4663 or visit www.sears.com/partsdirec
in the U.S. or www.sears.ca in Canada.
Obtenez des filtres de rechange au magasin SEARS[MD] le
plus près de chez vous en composant le 1-888-473-2772
ou en visitant www.sears.com/partsdirect aux États-Unis
et www.sears.ca au Canada.

Part # 9020 / N° de pièce 9020B

PUR®
REFRIGERATOR WATER FILTRATION
FILTRATION D'EAU POUR RÉFRIGÉRATEUR

ULTIMATE REFRIGERATOR FILTER
FILTRE POUR RÉFRIGÉRATEUR

ULTIMATE REFRIGERATOR FILTER

Replacement cartridge #T1RFKB1 for Model #T1KB1

Operating Temperature:	100°F (38°C) max
Working Pressure:	120psi (827 k Pa) max
Flow Rate:	0.5 gpm (1.89 Lpm)

This is a mechanical and chemical reduction filter. Filter capacity is up to 100 gallons/379 liters for refrigerators with a PID indicator.

FILTRATION ULTIMATE POUR RÉFRIGÉRATEUR

Cartouche de rechange n° T1RFKB1 pour le modèle n° T1KB1

Température de service :	100 °F (38 °C) max
Pression de service :	120 psi (827 kPa)
Débit :	0,5 gal/m (1,89 L/m)

Ce filtre a une capacité de réduction mécanique et chimique. Il peut traiter jusqu'à 379 litres d'eau pour les réfrigérateurs munis d'un indicateur PID.

Whirlpool, KitchenAid and PÜR recommend changing filter at least every 6 months
Whirlpool, KitchenAid et PÜR recommandent de changer le filtre au minimum tous les six mois

NSF International, a nationally recognized not-for-profit agency for the certification of water filters, has tested and certified this product to reduce the following list of contaminants. Products with the NSF mark are certified to pass a series of stringent independent tests.

NSF REPLACEMENT ELEMENT

Tested and certified by NSF International against NSF/ANSI Standard 53 in model number T1KB1 for the reduction of Lead, Cysts, Turbidity, TTHM, Asbestos, Mercury, Toxaphene, MTBE, Atrazine, Lindane, Alachlor, Endrin, Benzene, o-Dichlorobenzene, Tetrachloroethylene, Ethylbenzene, and Monochlorobenzene and Standard 42 for Chlorine Taste and Odor, and Nominal Particulate Reduction Class I.

The contaminants or other substances removed or reduced by this water filter are not necessarily in all users' water.

Do not use with water that is microbiologically unsafe or of unknown quality without adequate disinfection before or after the system. Systems that are certified for cyst reduction may be used on disinfected water that may contain filterable cysts. Individuals requiring water of certain microbiological purity should consult their physician.

NSF International, un organisme à but non lucratif reconnu à l'échelle nationale pour la certification des filtres à eau, a testé et certifié ce produit pour la réduction des contaminants énumérés ci-dessous. Le NSF certifie que les produits portant son sigle ont satisfait à une série de tests indépendants rigoureux.

NSF ÉLÉMENT DE RECHANGE

Testé et certifié par NSF International conformément à la norme NSF/ANSI n° 53 relative à la réduction de la teneur en plomb, kystes, turbidité, THM, amiante, mercure, toxaphène, éther méthyltertiobutylique, atrazine, lindane, alachlore, endrine, benzène, o-dichlorobenzène, tétrachloroéthylène, éthylbenzène et chlorobenzène, et à la norme n° 42 relative à la diminution du goût et de l'odeur du chlore et à la réduction nominale des particules de classe I pour le modèle T1KB1.

Les contaminants ou autres substances éliminés en totalité ou en partie par ce filtre ne sont pas nécessairement présents dans l'eau de tous les utilisateurs.

Ne pas utiliser avec de l'eau insalubre du point de vue microbiologique ou de qualité incertaine, sans prévoir une désinfection efficace avant ou après la filtration. Les systèmes ayant reçu la certification pour la réduction de la présence des kystes peuvent être utilisés avec de l'eau désinfectée pouvant contenir des kystes de taille filtrable. Les personnes qui doivent consommer une eau particulièrement pure sur le plan microbiologique devraient consulter leur médecin.

IMPORTANT NOTICE - Read the manufacturer's performance data sheet.
California Department of Health Services Certification # 04-1605 for model T1KB1. For conditions of use, health claims certified by the California Department of Health Services, and replacement parts, see Performance Data Sheet in your refrigerator Use & Care Manual.
Made in the U.S.A. Distributed by Sears Roebuck & Co., Hoffman Estates, IL 60179. Kenmore® is a registered trademark of Sears Brands, LLC. PUR is a registered trademark of The Procter & Gamble Company.

AVIS IMPORTANT - Lire la fiche technique de performance du fabricant.
Numéro de certification du California Department of Health Services 04-1605 pour le modèle T1KB1. Pour connaître les conditions d'utilisation, les informations en matière de santé certifiées par le California Department of Health Services et les pièces de rechange, consulter la fiche technique de performance dans le guide d'utilisation et d'entretien du réfrigérateur.
Fabriqué aux États-Unis. Distribué par Sears Roebuck & Co., Hoffman Estates, IL 60179. Kenmore[MD] est une marque déposée de Sears Brands, LLC. PUR est une marque déposée de The Procter & Gamble Company.

EPA EST. No. 070595-CT-001 US Patents pending Label/Étiquette n° 2260536
Est. EPA n° 070595-CT-001 Brevets américains en instance 95248869

Replacement cartridge #T1RFKB1 for model #T1KB1

Cartouche de rechange n° T1RFKB1 pour le modèle n° T1KB1

Part# 2260538
N° de pièce 2260538

"Ultimate Refrigerator Filter"

$44.98 (2007)

$54.98 (2011)

not including shipping, handling and tax

..replace every five months

$132+ per year

Contact Information

john@h2oc.com

tom@ h2oc.com

1-877-22-WATER

Sustainability for Water Systems

Tom O'Connor, PE

H_2O'C Engineering

tom@h2oc.com

877-22-WATER

Definitions of Sustainability

"Meeting the needs of the present without compromising the ability of future generations to meet their own needs."

- Brundtland Commission of the United Nations, March 20, 1987

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Definitions of Sustainability

"Improving the quality of human life while living within the carrying capacity of supporting ecosystems."

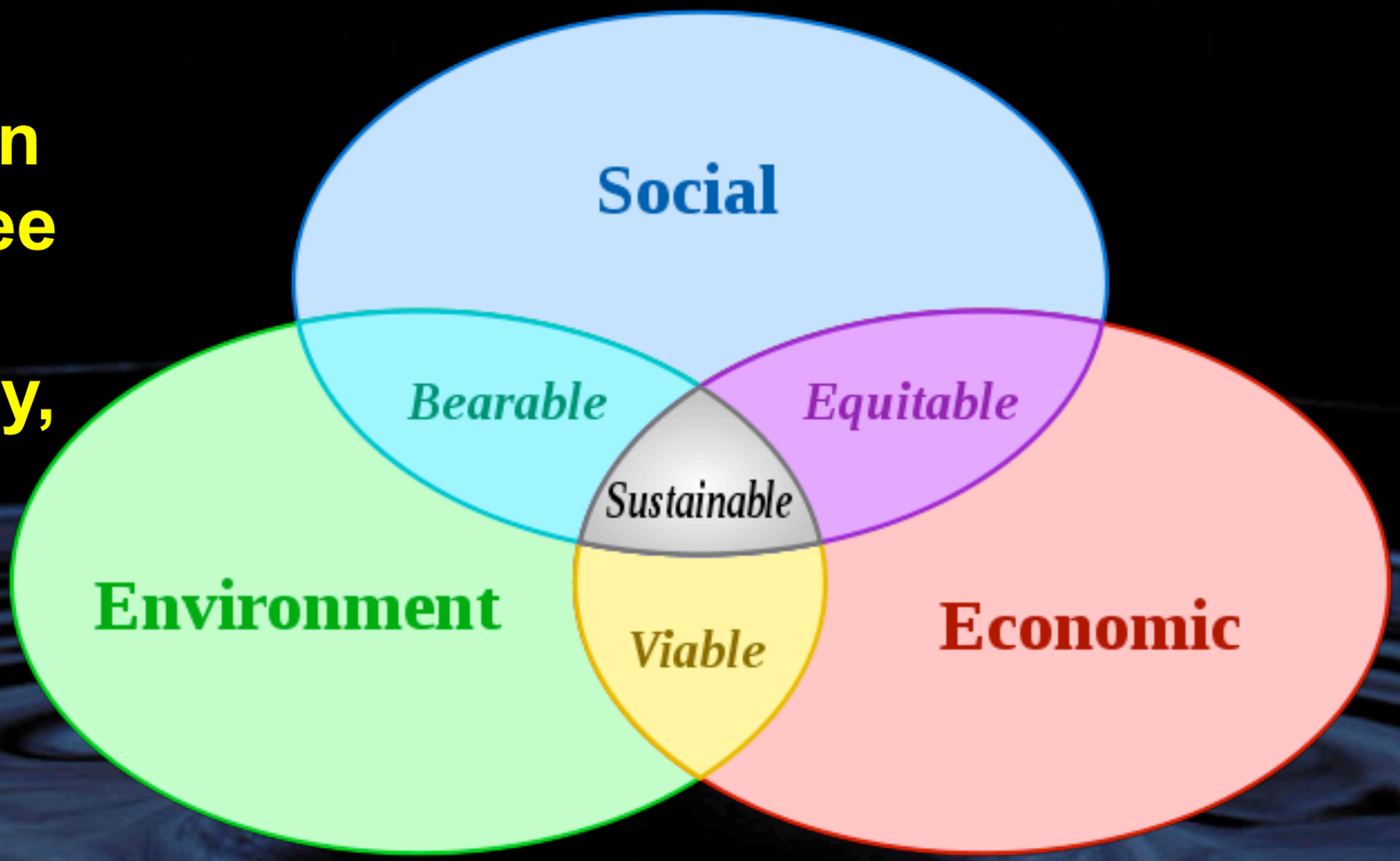
- IUCN, UNEP, WWF (1991): Caring for the Earth. A Strategy for Sustainable Living.

H2O'C ENGINEERING

Definitions of Sustainability

"Sustainable development is often thought to have three components: environment, society, and economy. The well-being of these three areas is intertwined, not separate."

- McKeown, R. (2002), The ESD Toolkit 2.0.



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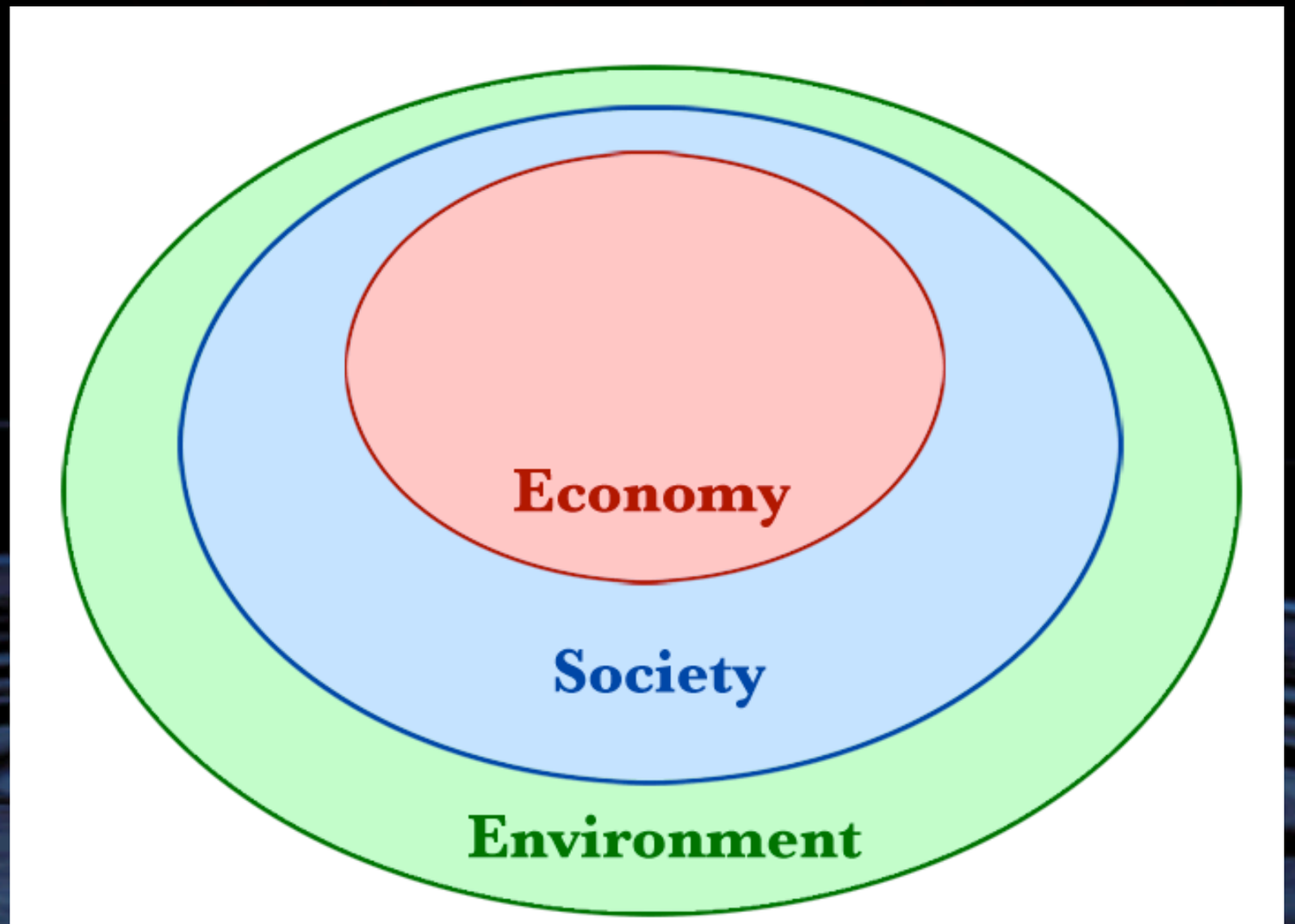
Definitions of Sustainability

Updated Diagram:

Economy is a subset of Society, which is a subset of Environment



H2O'C ENGINEERING

AWWA Sustainability Policy

“AWWA advocates sustainability of drinking water utilities through the provision of adequate and reliable water supply of desired quality -- now and for future generations -- in a manner that integrates economic growth, environmental protection and social development.”

- Statement of Policy on Public Water Supply Matters, Adopted by the Board of Directors Jan. 23, 2011.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
Sustainable Infrastructure for Water & Wastewater
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EPA's Four Pillars of Sustainable Water and Wastewater Infrastructure*

1. ***Better Management*** **of Water & Wastewater Utilities**
2. **Rates that Reflect the *Full Cost Pricing* of Services**
3. ***Efficient Water Use***
4. ***Watershed Approaches*** **to Protection**

*** not to be confused with actual sustainability**

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Sustainability: The Buzzword

Beware the Greenwashing:

A few curly light bulbs do not sustainability make

Implications of Sustainability

Ultimately, by Definition:

All Energy Must be Renewable

Which Means:

No Dependency on Fossil Fuels

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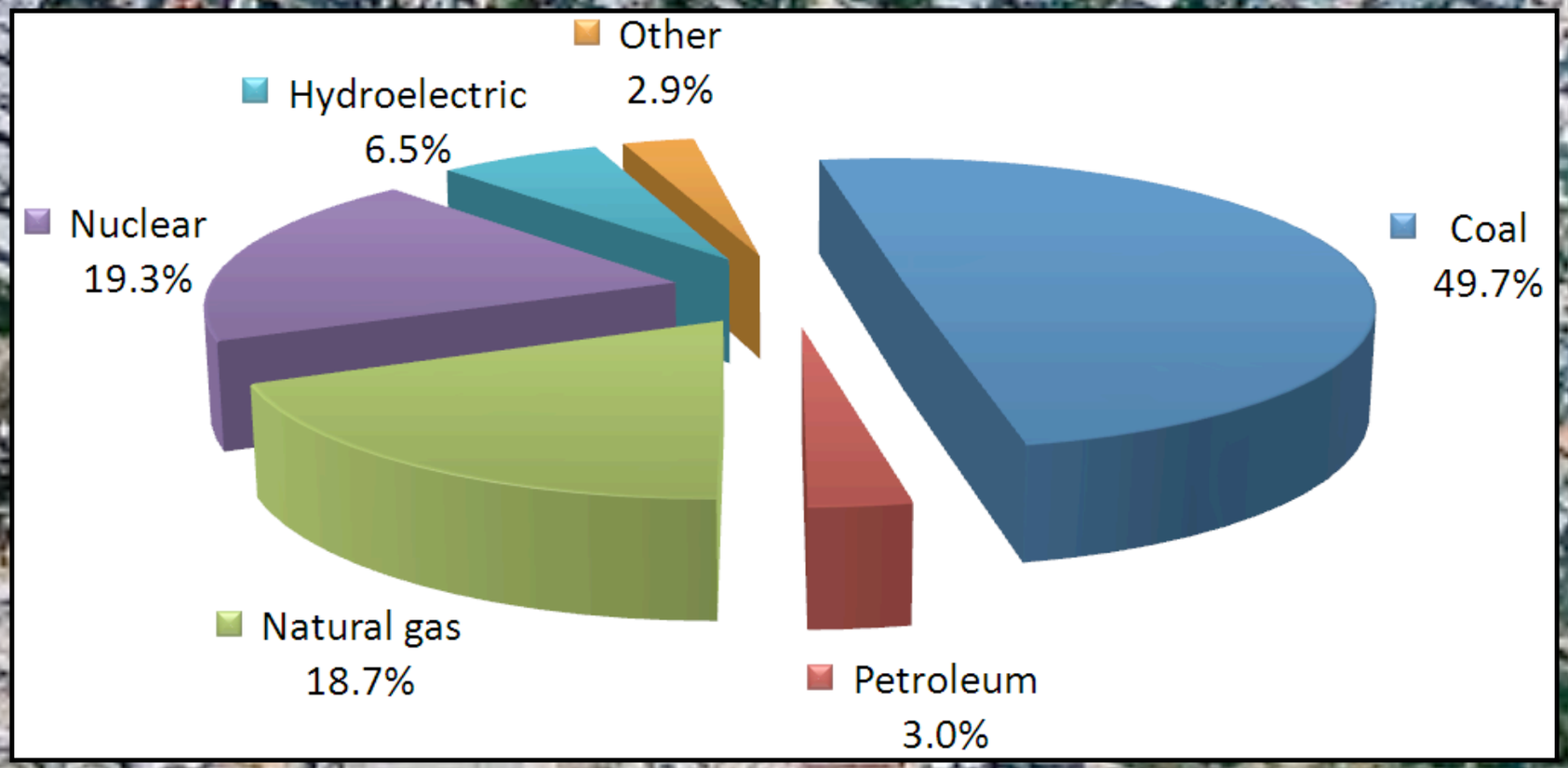


How can we get there from here?

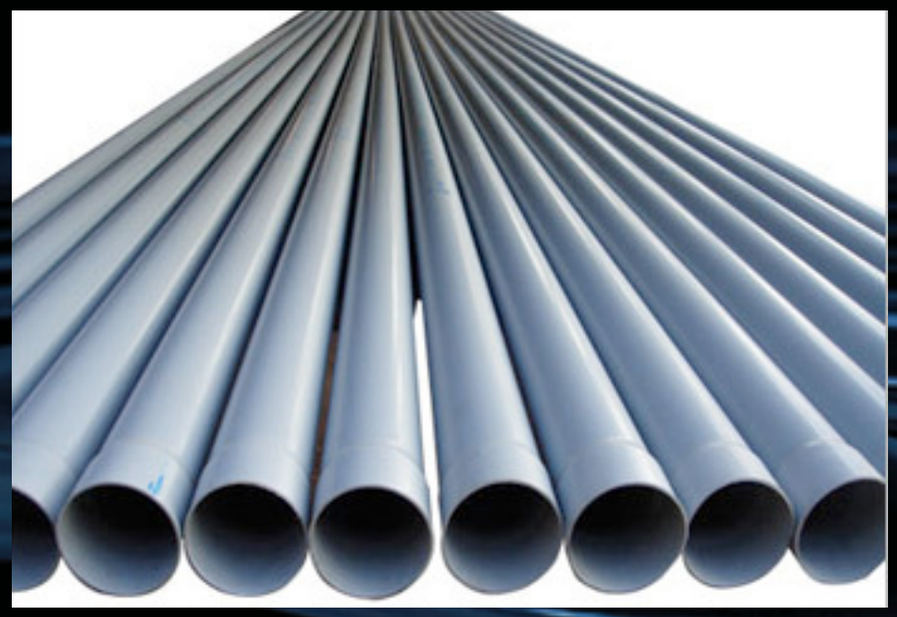
Impediments to Sustainability

Modern Water Supply is an Energy-Intensive Operation

- direct energy use (pumping)
- indirect, embedded energy (concrete, chemicals, materials)

- ALSO: source water depletion or degradation

What are the Most Sustainable Options for Materials Commonly Used in Water Systems?



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Pipe Fight!

“HDPE pipe is the best product for developing a truly sustainable infrastructure. From its low energy cost to produce, ship and install... there is no other material that approaches the performance and versatility of HDPE pipe.”

- HDPE pipe trade association guy

“All municipalities want sustainable, long-lasting and cost-effective piping technologies. Ductile iron pipelines offer such sustainable features. Its raw material is scrap iron... recycle heat and process waters...”

- Iron pipe trade association guy

“PVC pipe combines the ageless durability that comes with a corrosion-free material with the overall strength... PVC is arguably the most sustainable and cost-effective of all pipe materials.”

- PVC pipe trade association guy

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Can we get a Referee?

Difficult to find objective, accurate, up-to-date, research-based, scientific information

Embodied carbon comparison

Material	Embodied carbon* kg CO^2/kg	Weight of 4" pipe (lbs/lf)	Weight of 4" pipe (kg/lf)	Embodied carbon kg CO^2/kg for 4" pipe per lf
HDPE (DR-11)	1.60	2.30 typ.	1.04	1.66
PVC Sch. 40	2.50	2.10 typ.	0.95	2.38
Iron	1.91	13 typ.	5.90	11.27

*Data taken from "Inventory of Carbon and Energy (ICE)", published by the Sustainable Energy Research Team (SERT), University of Bath.

Departament de Projectes d'Enginyeria

UNIVERSITAT POLITÈCNICA DE CATALUNYA

Environmental Modelling Laboratory

Estimate of energy consumption and CO_2 emission associated with the production, use and final disposal of PVC, HDPE, PP, ductile iron and concrete pipes

Table 8.14. Energy consumption and CO_2 emissions attributable to the production and use (50 years) of pipes made of different materials considering processes of deconstruction, recycling and final disposal of materials. Summary.

Calculation base: 3 m of pipe without accessories (Recycled material % weight)	RD	Weight of pipe	s	Hazen Williams coeff.	Energy consumption	CO_2 emissions	Variation energy consumption vs. ref. std.	Variation CO_2 emissions vs. ref. std.
	mm	kg m^{-1}	m s^{-1}		kWh	kg CO_2	%	%
SUPPLY PIPES								
Bioriented PVC	110	1.1	1.4	--(1)	829.1	363.2	-20.58	-19.81
PVC	110	2.7	1.5	150	1043.9	453.0	0.00	0.00
HDPE	125	3.8	1.4	140	1058.9	455.2	1.43	0.48
Ductile iron (80% recycled material)	125	21.6	0.9	100 (2)	1336.8	589.1	28.06	30.05
Ductile iron	125	21.6	0.9	100 (2)	1641.1	689.0	57.20	52.10

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Environmental Modelling Laboratory

There’s always Wood…

Old wooden pipe on display in Excelsior Springs, MO

Water and Wastewater Energy

- Water and wastewater industries use an estimated **75 billion kWh/year**.
- Drinking water and wastewater systems in the US spend about **$4 billion/year** on energy to pump, treat, deliver, collect, and clean water.
- Energy costs for water and wastewater can be 1/3 of a municipality's total energy cost.
- Cost savings from even a modest 5-10% improvement can be substantial.

www.schloerb.com

Water Energy Usage

- Majority of energy use: pumping
- Energy use affected by: water source, quality, treatment process, storage, elevations, distances, age/condition of infrastructure
- Major processes: production, treatment, and distribution

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Water System Electrical Usage (3-4 MGD)

	Unit	Usage, kWh/month
Well pumps	kWh	64,228
WTP	kWh	106,177
5 MG Reservoir	kWh	4,927
Linden Tower	kWh	75
Antioch Tower	kWh	281
TOTAL	kWh	**175,688**

Water System Carbon Emissions: Chemical & Electrical Usage

	Tons of CO_2 per month
Electricity	155
Gasoline	0.3
Lime	95
Carbon Dioxide	0
Chlorine	0.1
Aeration	3
Total	253.4

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Water System Energy Requirements

Rule o' Thumb

1.4 - 1.9 kWh/1,000 gal

1.4 - 1.9 MWh/MG

Not very much, really.

A typical US household uses about 30 kWh of electricity per day.

The ~300 gallons of water used daily by a typical household represents about 0.5 kWh.

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Review of Renewable Energy Alternatives

Wind Resources Map

Missouri
50 m Wind Power

Maryville
Kirksville
St. Joseph
Chillicothe
Hannibal
Mobery
Kansas City
Marshall
Columbia
Sedalia
Jefferson City
Saint Louis
Clinton
Nevada
Rolla
Farmington
Cape Girardeau
Springfield
Joplin
Sikeston
Poplar Bluff
West Plains

40°
38°
36°
92°
90°

Transmission Line*
Voltage (kV)
115 - 161
345
500
* Source: POWERmap, ©2004 Platts, a Division of the McGraw-Hill Companies

Wind Power Classification

Wind Power Class	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
1	0 - 200	0.0 - 5.6	0.0 - 12.5
2	200 - 300	5.6 - 6.4	12.5 - 14.3
3	300 - 400	6.4 - 7.0	14.3 - 15.7

[a] Wind speeds are based on a Weibull k value of 2.0

50 0 50 100 150 Kilometers
25 0 25 50 75 100 Miles

The annual wind power estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

NREL
U.S. Department of Energy
National Renewable Energy Laboratory

31-JAN-2005 1.1.1

Little Wind

- Air X Wind Turbine
- 400 watts
- $600
- demonstration unit
- portable testing
- evaluate wind resources at different locations, elevations

Vertical Axis Wind Turbine (VAWT)

- 2.5 kW, 5 kW
- cut-in speed 8 mph
- $4/watt
- less efficient than HA,

but may perform better at lower elevations or in swirling wind

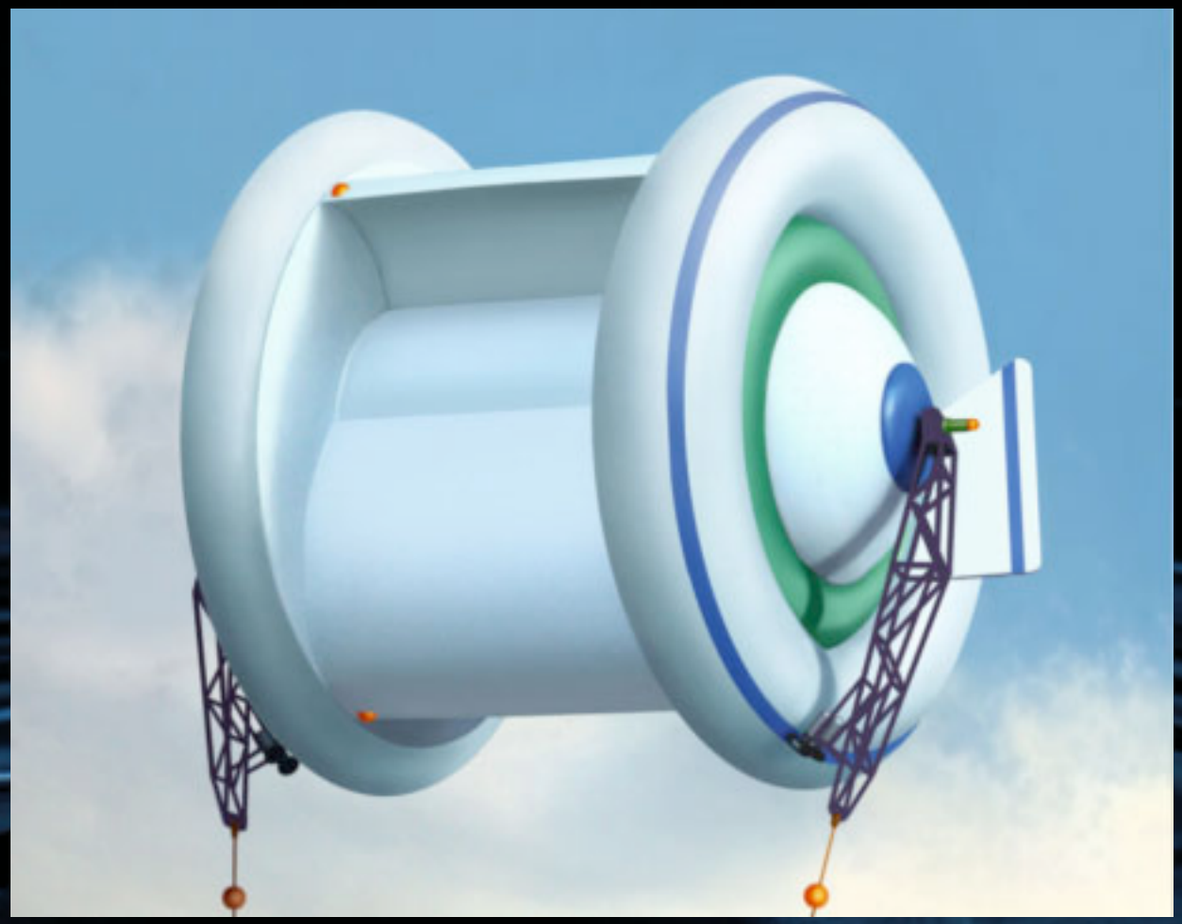
Large-Scale Wind

- 1.65 MW
- $1.89 Million
- $1.15/Watt !

ILLINOIS RURAL
ELECTRIC COOPERATIVE
PIKE COUNTY WIND PROJECT
Project consists of the construction and operation of a single 1.65 mega-watt wind turbine
Contracted by: VESTAS AMERICAS, INC.
Financed by:
UNITED STATES DEPARTMENT OF AGRICULTURE - RURAL DEVELOPMENT
ILLINOIS DEPARTMENT OF COMMERCE AND ECONOMIC OPPORTUNITY
ILLINOIS CLEAN ENERGY COMMUNITY FOUNDATION
UNITED STATES DEPARTMENT OF AGRICULTURE - RURAL UTILITIES SERVICE
FEDERAL LAW PROHIBITS DISCRIMINATION BECAUSE OF RACE, COLOR, RELIGION, SEX, NATIONAL ORIGIN, AGE, MARTIAL STATUS AND PHYSICAL/MENTAL HANDICAP.

Pie-in-the-Sky Wind

- Magenn
- helium-filled
- tethered at 1,000’
- ~ $5 per Watt
- 100kW unit
- available... ?



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Solar Power: Photovoltaics

Solar Power: Photovoltaics

- < $5/Watt (and dropping)
- One kW of PV capacity produces about 5 kWh/day
- Typical water system uses ~1.5 kWh/1,000 gal
- Need ~ 300 kW of PV to make 1 MGD
- $ 1.5 million (~1 acre) of solar panels
- “Store” energy in the form of treated, elevated water

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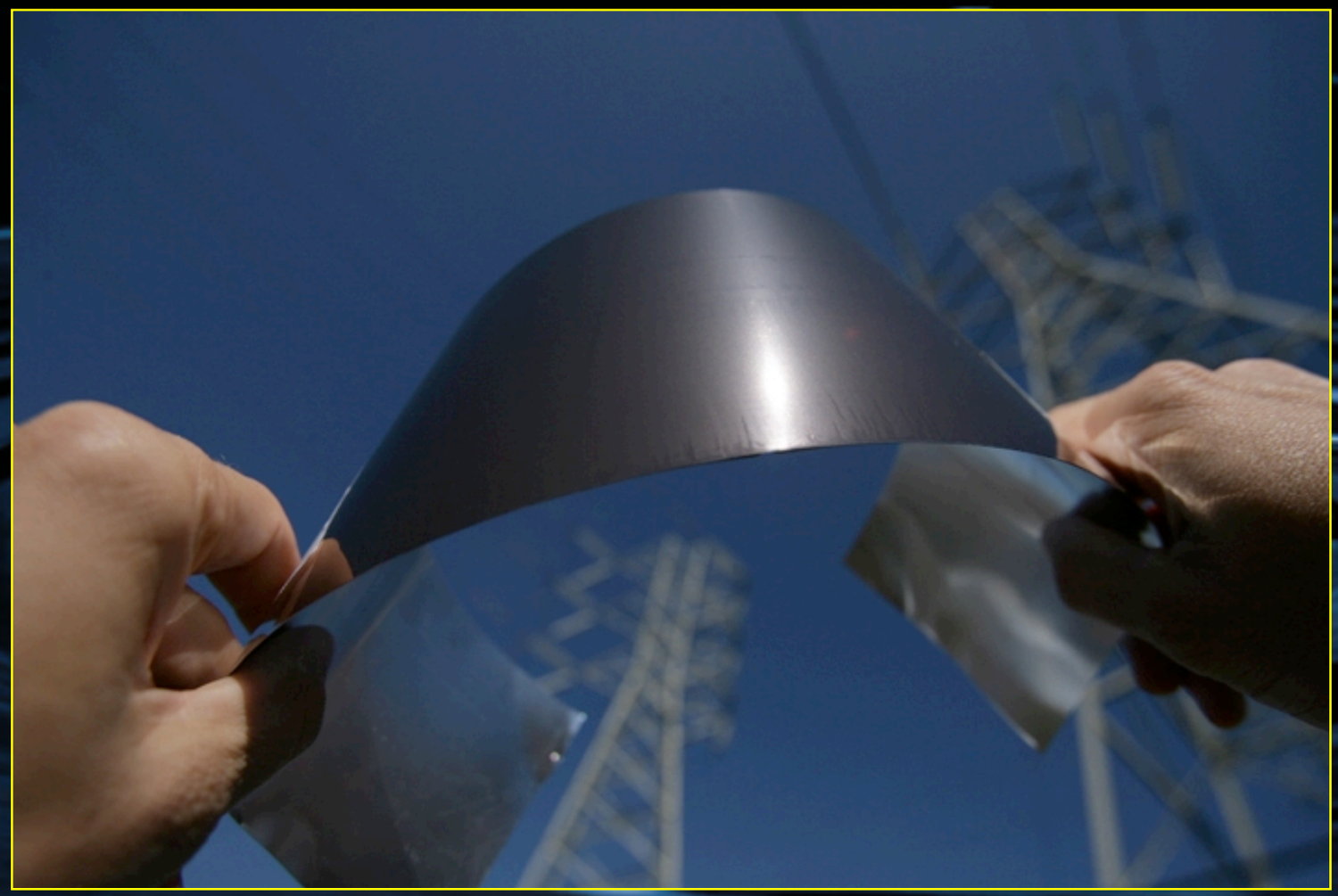
Future Photovoltaics

nanosolar

SolarPly thinfilm: $1/Watt (allegedly)



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Concentrated Solar Power

- more efficient than photovoltaic
- less commercially-developed
- National Renewable Energy Labs
- large-scale installations worldwide

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Concentrated Solar Power

1. Stirling engine/parabolic dish
2. linear concentrator
3. power tower

Concentrated Solar Power

1. Stirling engine/parabolic dish

Concentrated Solar Power

- Infinia Stirling engine/dish
- cost “slightly less than PV equivalent”

Concentrated Solar Power

2. linear concentrator

Concentrated Solar Power

3. power tower

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Energy Conservation

Minimize Energy Usage Before

Incorporating Renewables

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Energy Audit

Water and Wastewater
Energy Best Practice Guidebook

Provided By:

focus on energy℠
The power is within you.

Funding for this guidebook was provided by Focus on Energy.
Focus on Energy is a public-private partnership offering energy information and services to energy utility customers throughout Wisconsin. The goals of this program are to encourage energy efficiency, use of renewable energy, enhance the environment and ensure the future supply of energy for Wisconsin.

Prepared by:

Science Applications International Corporation (SAIC)

December 2006

Energy Audit

1) Establish a Baseline Energy Use

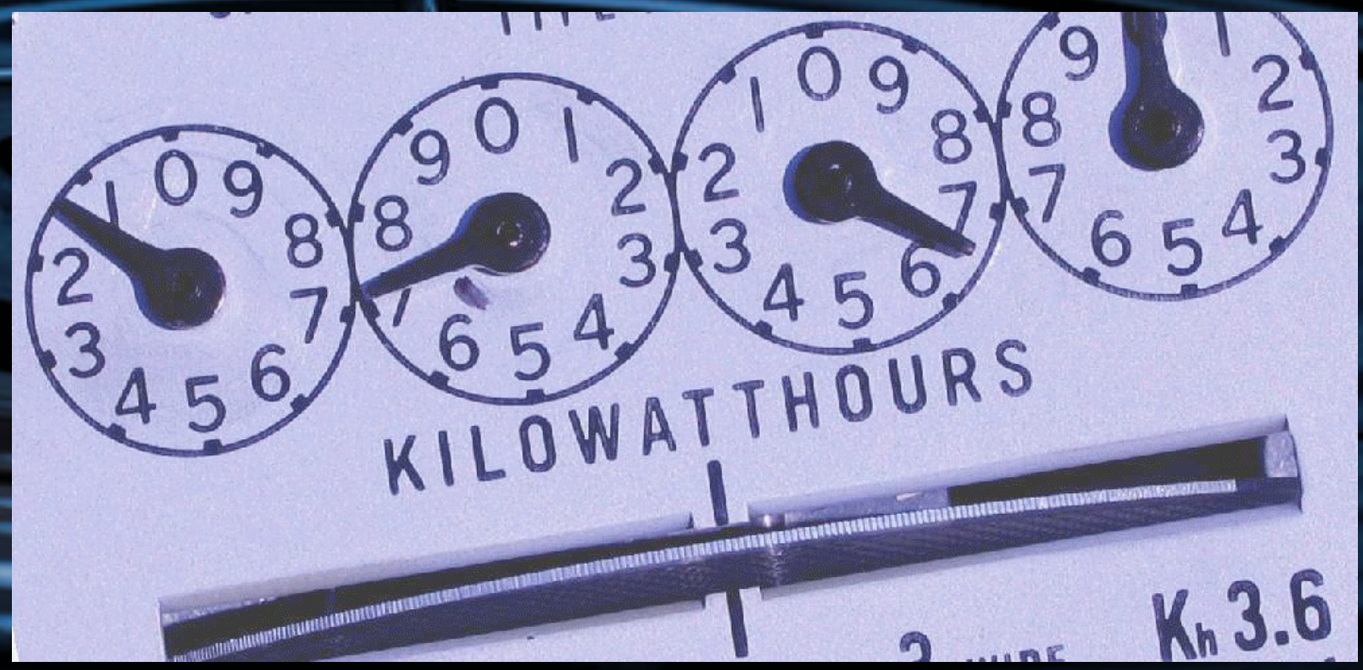
2) Estimate Energy Use for Major Systems

3) Identify Best Practice Opportunities

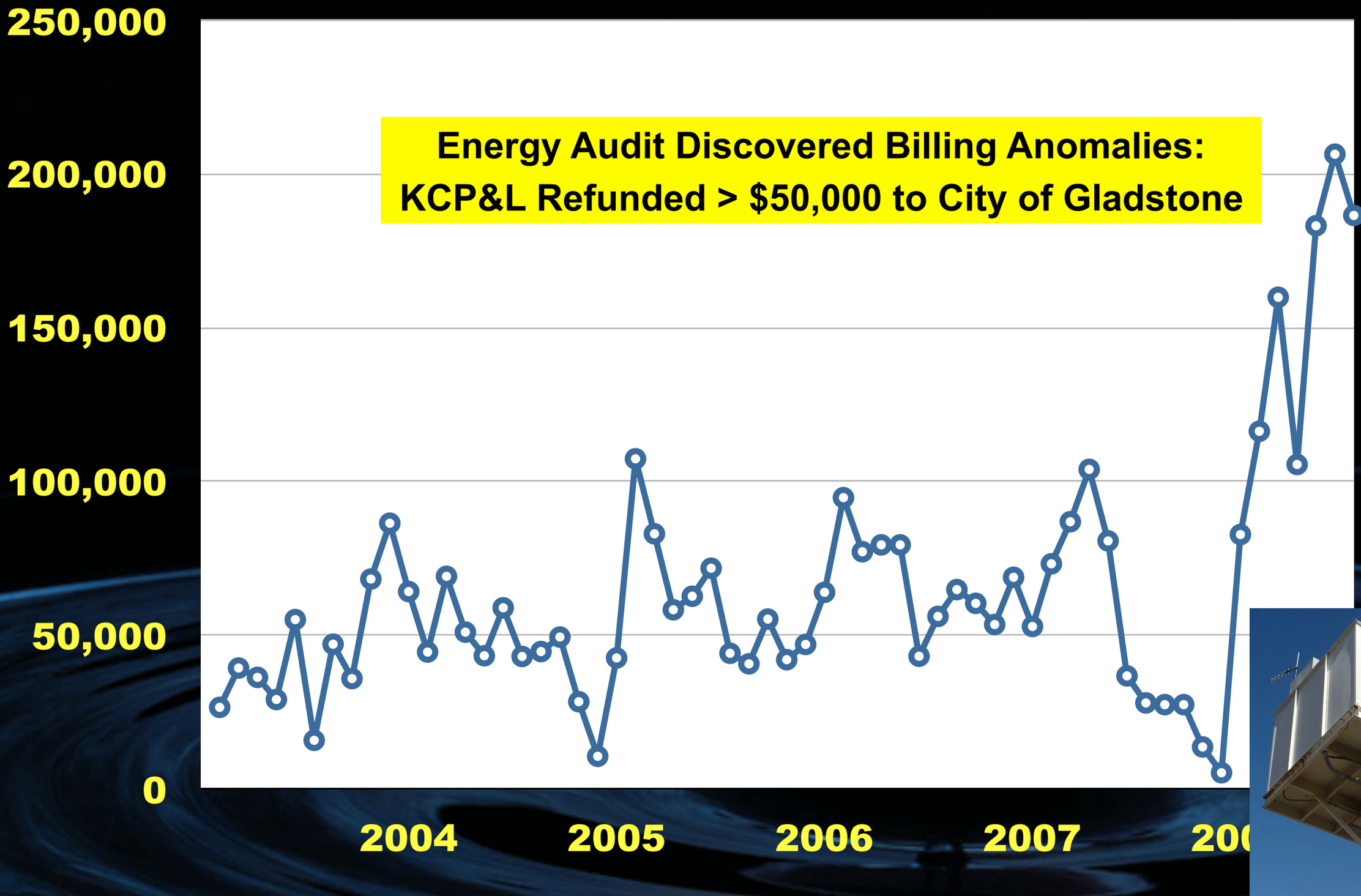
4) Quantify Benefits and Project Costs of Best Practice Opportunities

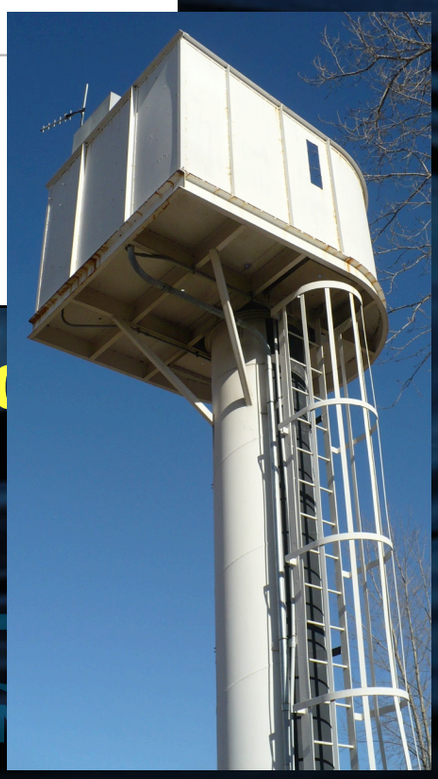
5) Prioritize Projects

6) Project Management



Electrical Usage at Wells (kWh/month)

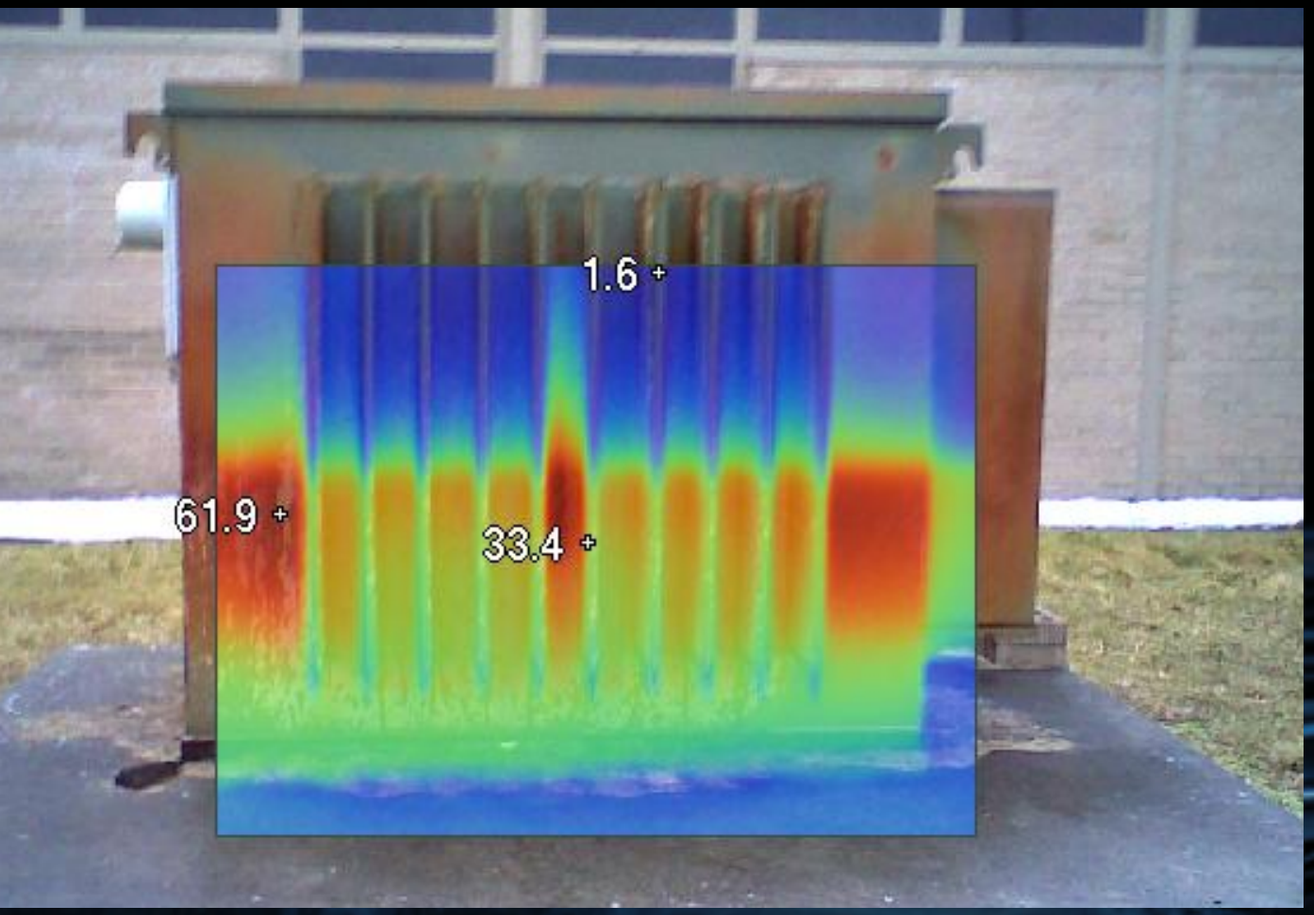


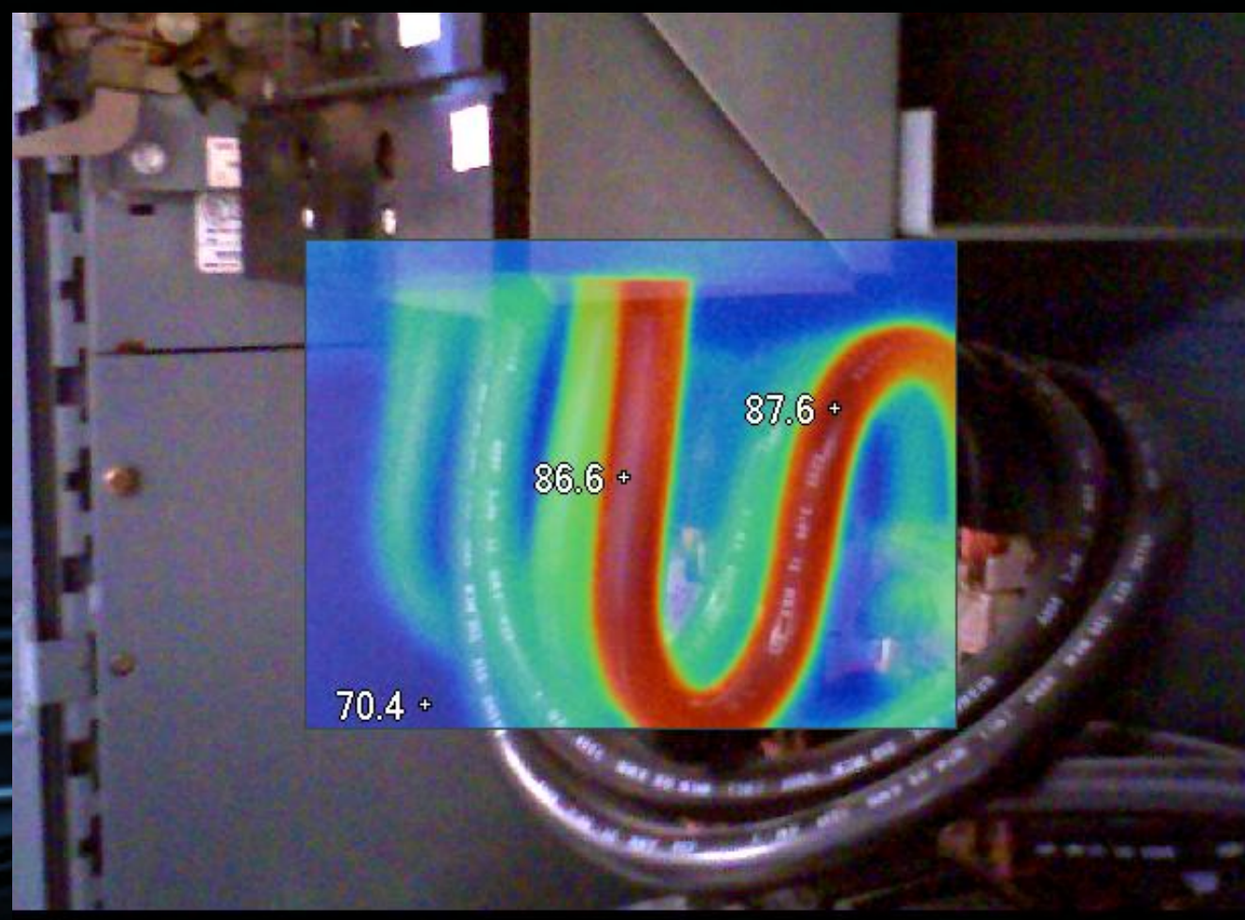


Average electrical usage for the wellfield:

64,228 kWh/month (2,141 kWh/day)

Thermal Imaging





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Water Supply Energy Best Practices

1) Automate to Monitor and Control
2) Integrate System Demand and Power Demand
3) Distribution System Model
4) Water Audit/Leak Detection and Repair
5) Variable Frequency Drives
6) Manage Well Production and Drawdown
7) Sequence Well Operation
8) Promote Water Conservation
9) Sprinkling Reduction Program
10) Manage High Volume Users

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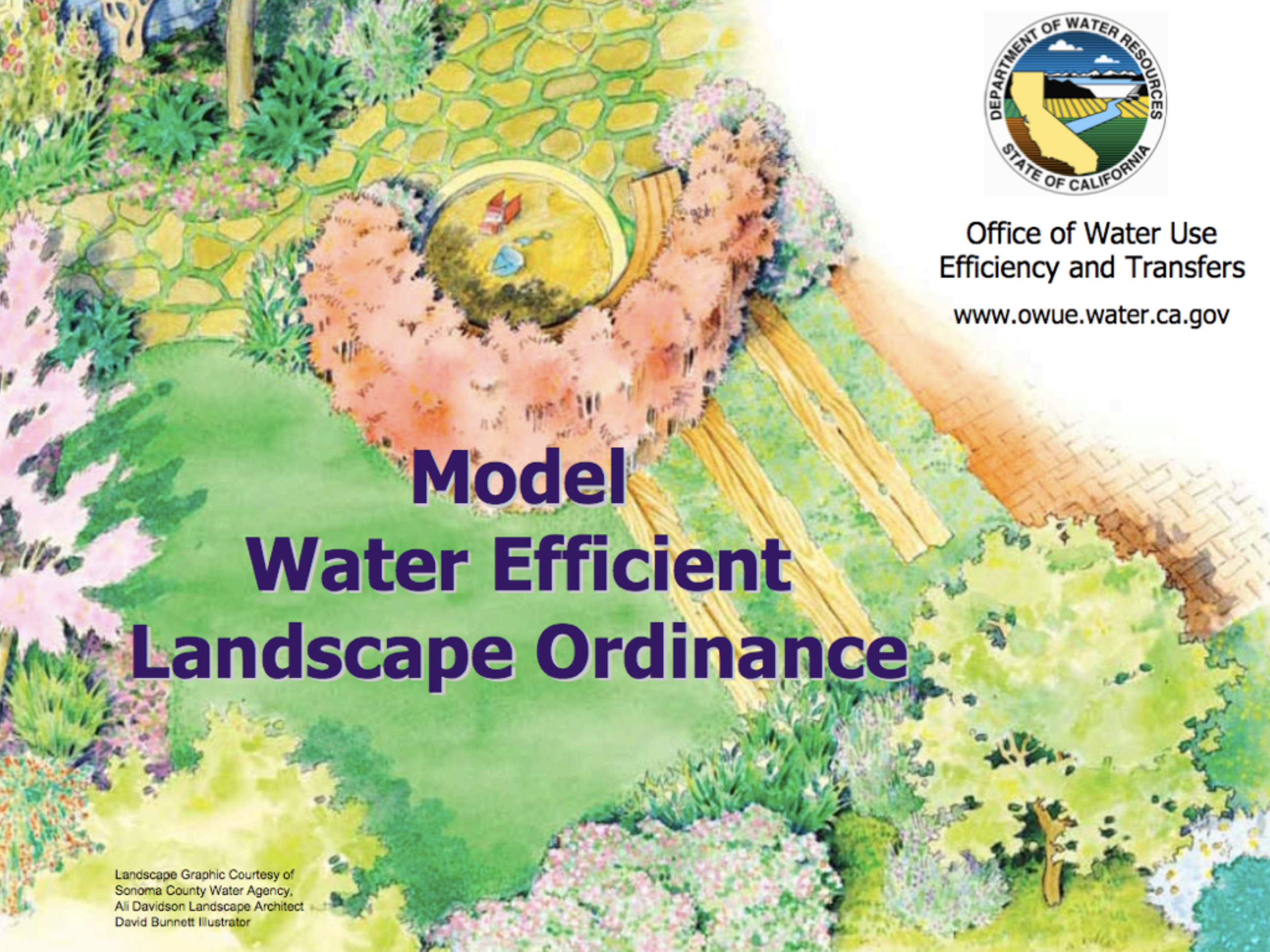
Water Conservation-Household

- EPA's WaterSense
- Rainwater Harvesting
- Graywater Reuse
- Xeriscaping

EPA WaterSense PARTNER

Water Usage: Room for Improvement

We use twice as much water as the French and four times as much as the British.



Office of Water Use
Efficiency and Transfers

www.owue.water.ca.gov

Model Water Efficient Landscape Ordinance

Landscape Graphic Courtesy of
Sonoma County Water Agency,
Ali Davidson Landscape Architect
David Bunnett Illustrator

Conservation and Efficiency

"Virtual" Water System Expansion:

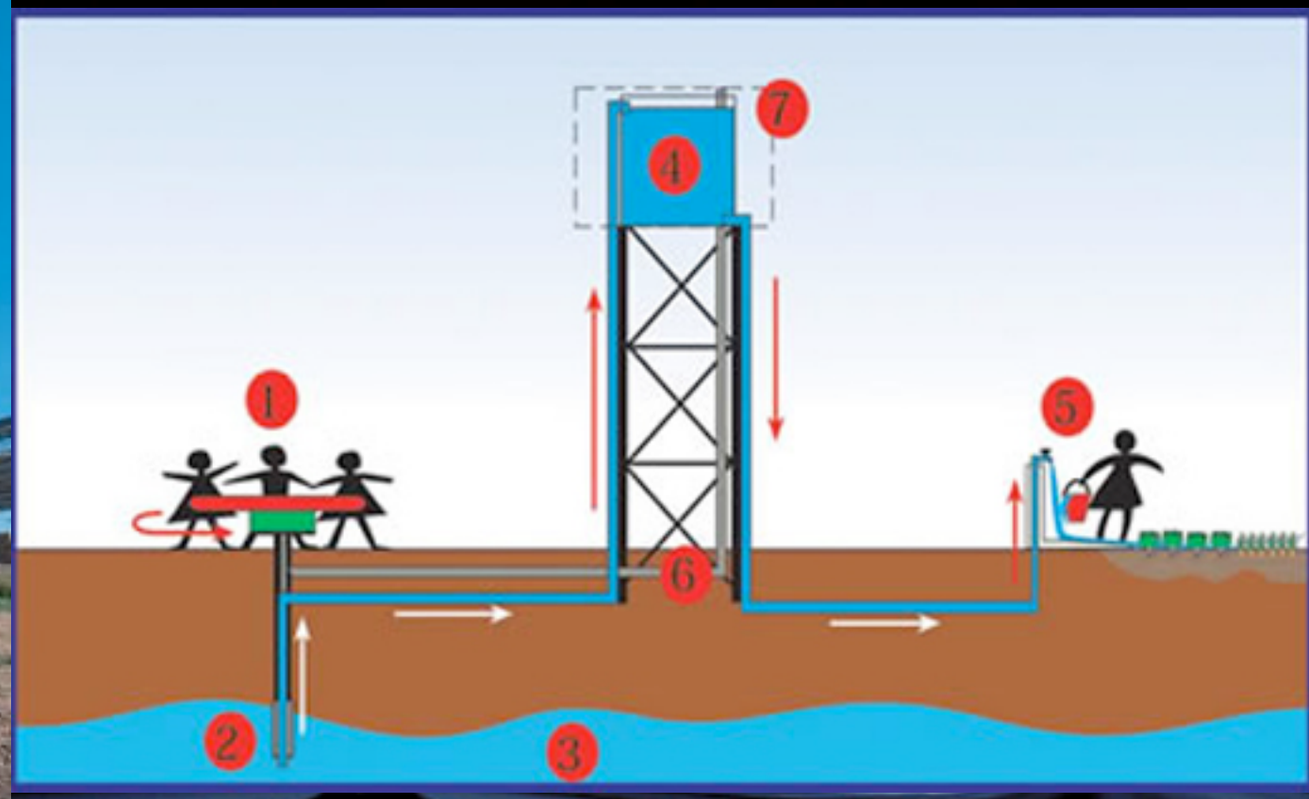
Reduce Demand rather than Increase Supply

1) Take the money that you were planning to spend on capacity expansion and allocate it to conservation programs and incentives (aka Demand Side Management).

2) Examine and update rates, policies, and ordinances regarding water use.

Sustainable Water System Examples

Sustainable Water Systems:
The Play Pump



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Sustainable Water Systems: Slap PV on a Filtration Unit

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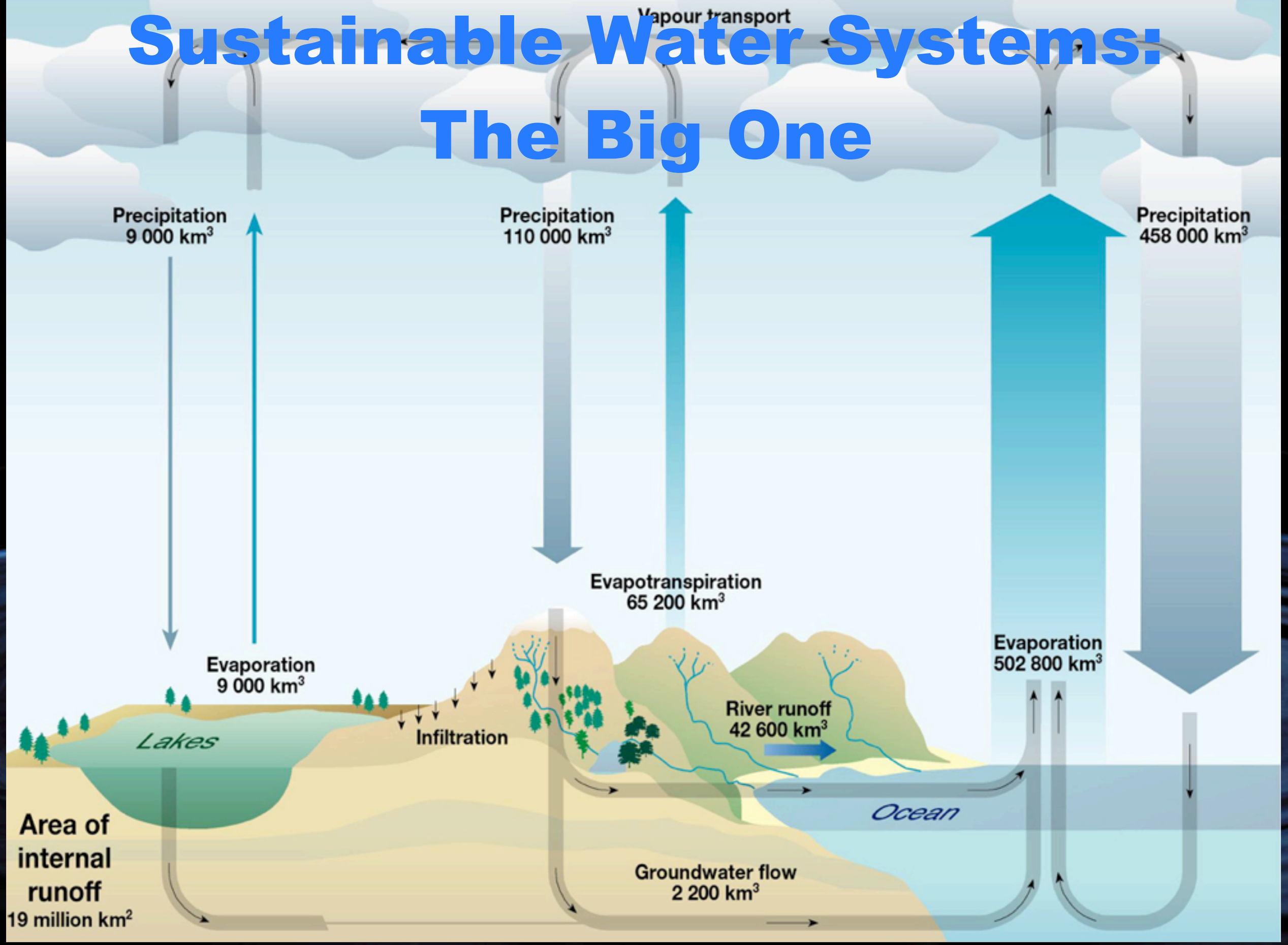
Sustainable Water Systems: The Big One



Vapour transport

Elevated Storage

Precipitation
9 000 km³

Precipitation
110 000 km³

Precipitation
458 000 km³

Extensive Distribution System

Solar-Powered Treatment (Distillation)

Evapotranspiration
65 200 km³

Evaporation
9 000 km³

Evaporation
502 800 km³

Infiltration

River runoff
42 600 km³

Lakes

Ocean

Area of internal runoff
19 million km²

Groundwater flow
2 200 km³

Moving Toward Sustainability

- **Triple Bottom Line:**
  Economic, Environmental, Social
- **Energy Audit (install VFDs)**
- **Renewables (Solar, Wind, Biodiesel)**
- **Aggressive Water Conservation**
  (EPA WaterSense and way beyond)

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Sustainability
for Water Systems

Tom O'Connor, PE

H_2O'C Engineering

tom@h2oc.com

877-22-WATER

Chapter 3

Sewage

A Brief History of Human Waste Disposal
- and its possible future.

Part 1. Cesspits & Outhouses

Part 2. Toilets & Water Carriage

Part 3. Sewerage

Part 4. Sewage Treatment

Part 5. Wastewater Treatment

Part 6. The Future: Wastewater Reclamation

A Brief History of

Human Waste Disposal

-- and its possible Future

Part 1. Cesspits & Outhouses
Part 2. Toilets & Water Carriage
Part 3. Sewerage
Part 4. Sewage Treatment
Part 5. Wastewater Treatment
Part 6. The Future:
Wastewater Reclamation

Dr. John T. O'Connor, PE
Tom O'Connor, PE

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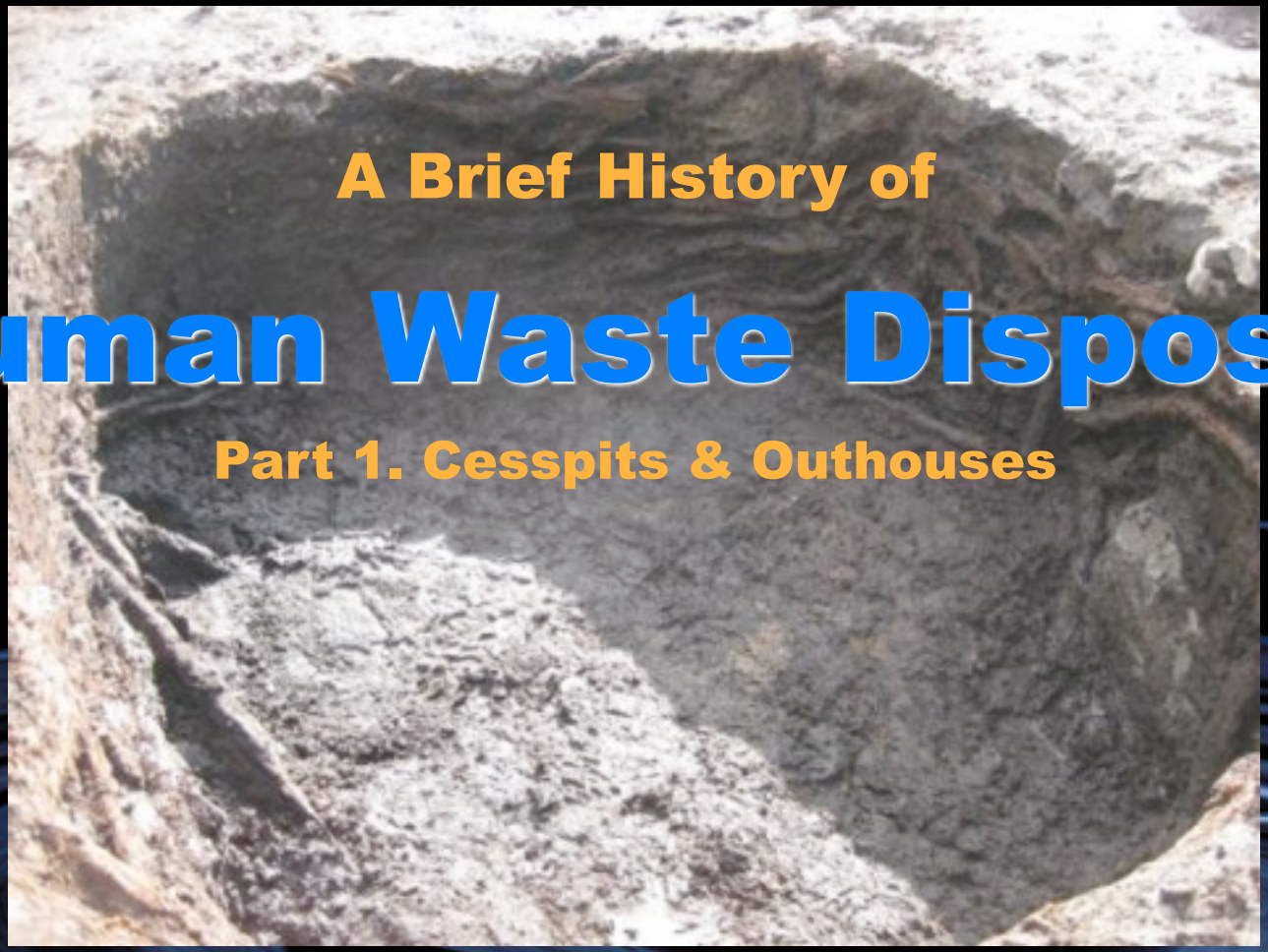

A Brief History of

Human Waste Disposal

Part 1. Cesspits & Outhouses

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Medieval Woodcut

Chamber Pot to Gutter Waste Disposal System

Rats, Pigs

Black Death

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England: ~1850

Sewers - Old English word for *'Seaward'*

Cesspit beneath floors; overflow to streets
London (1810): 200,000 cesspits/ 1 million

Windows sealed against *'Night Air', miasma*
a mix of coal smoke and sulfurous fog

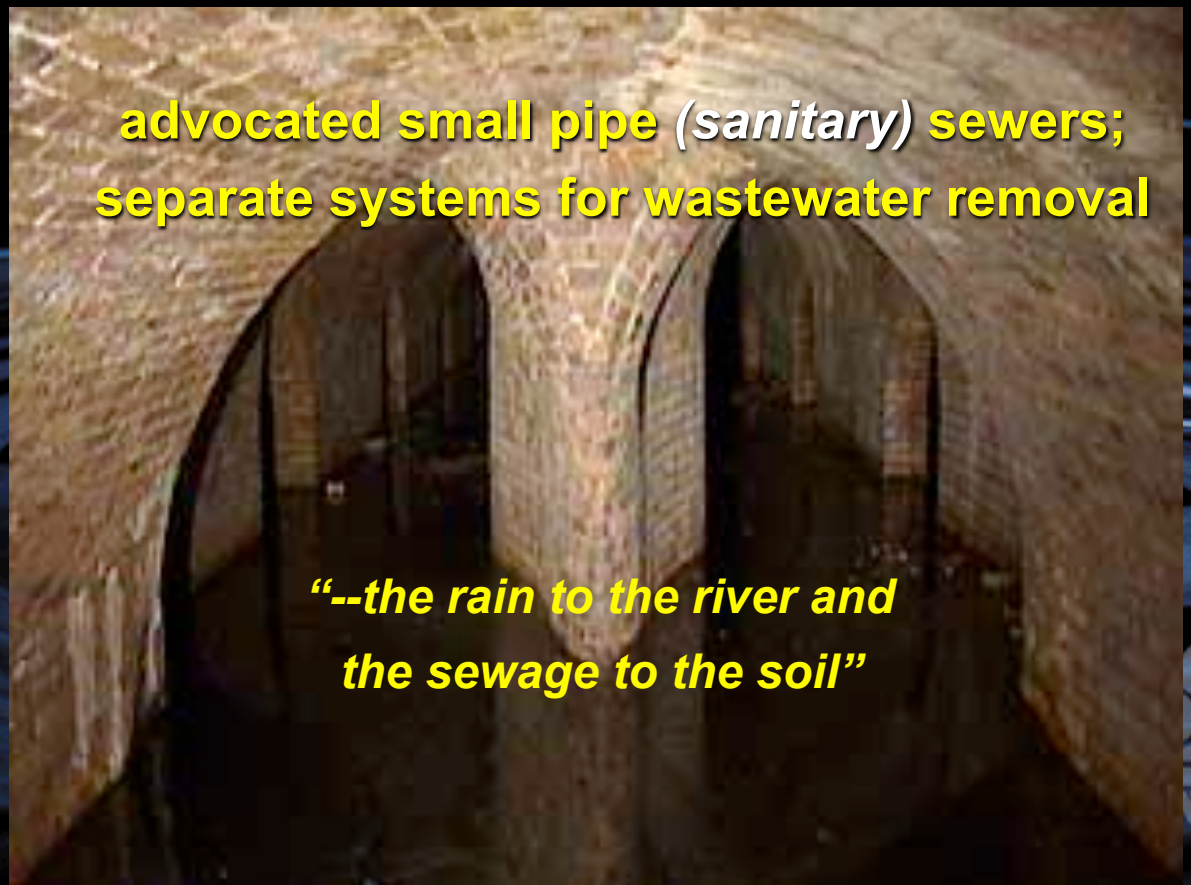
Asphyxiation common due to hydrogen sulfide and oxygen deficiency; methane explosions

Reclaimed *'Night Soil'* used as crop fertilizer; small children harvested cesspit wastes

Edwin Chadwick 1800-1850

Report of the *Poor Law Commissioners* on an

Inquiry into the Sanitary Condition of the Labouring Population of Great Britain, 1842:


advocated small pipe (sanitary) sewers;
separate systems for wastewater removal
"--the rain to the river and
the sewage to the soil"

Waste Disposal to 1850

Chamber Pots into Street Gutters

Cesspits, Cesspools under Houses:

Seepage, Overflow to Streets

Pit Privies and Soil Absorption

Sewage Farming 1840 - 1890

Broad Irrigation to Fields:

Poor Law Commissioners of England
1842

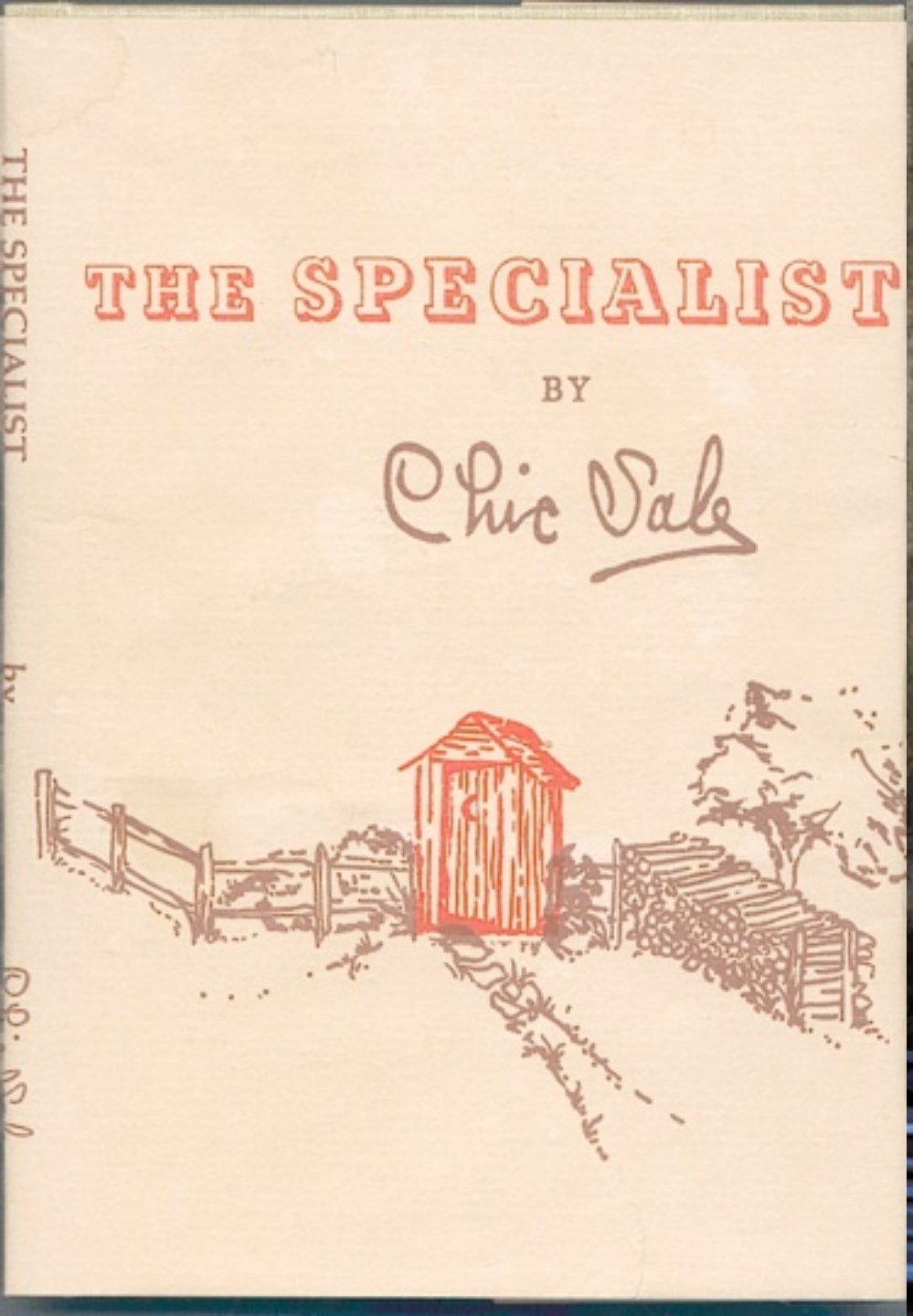
State Insane Asylum, Augusta, Maine
1875

(abandoned: resulted in clogged, stinky soils)

Western (arid) U.S. 1890

Peas, beans, tomatoes, corn, cabbage, alfalfa, fruit, ...

U.S. Sewage Farming ended ~1930


THE SPECIALIST
BY
Chic Sale
THE SPECIALIST by Chic Sale

Charles (Chic) Sales
documents the emergence of
The Specialist
(1929)
'... dig her deep and dig her wide...'
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Earth-Pit Privy

Design Criteria:

6 feet deep

50 cubic ft.

'.. lean-to roof has two less corners for the wasps to build their nests in..'

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Two-Storied Outhouse

for two-storied houses with two families

Design Capacity, Per Person
feces: 0.2 kg /day
urine: 1 liter /day

Unflattering metaphor for President Reagan's *'trickle down'* theory

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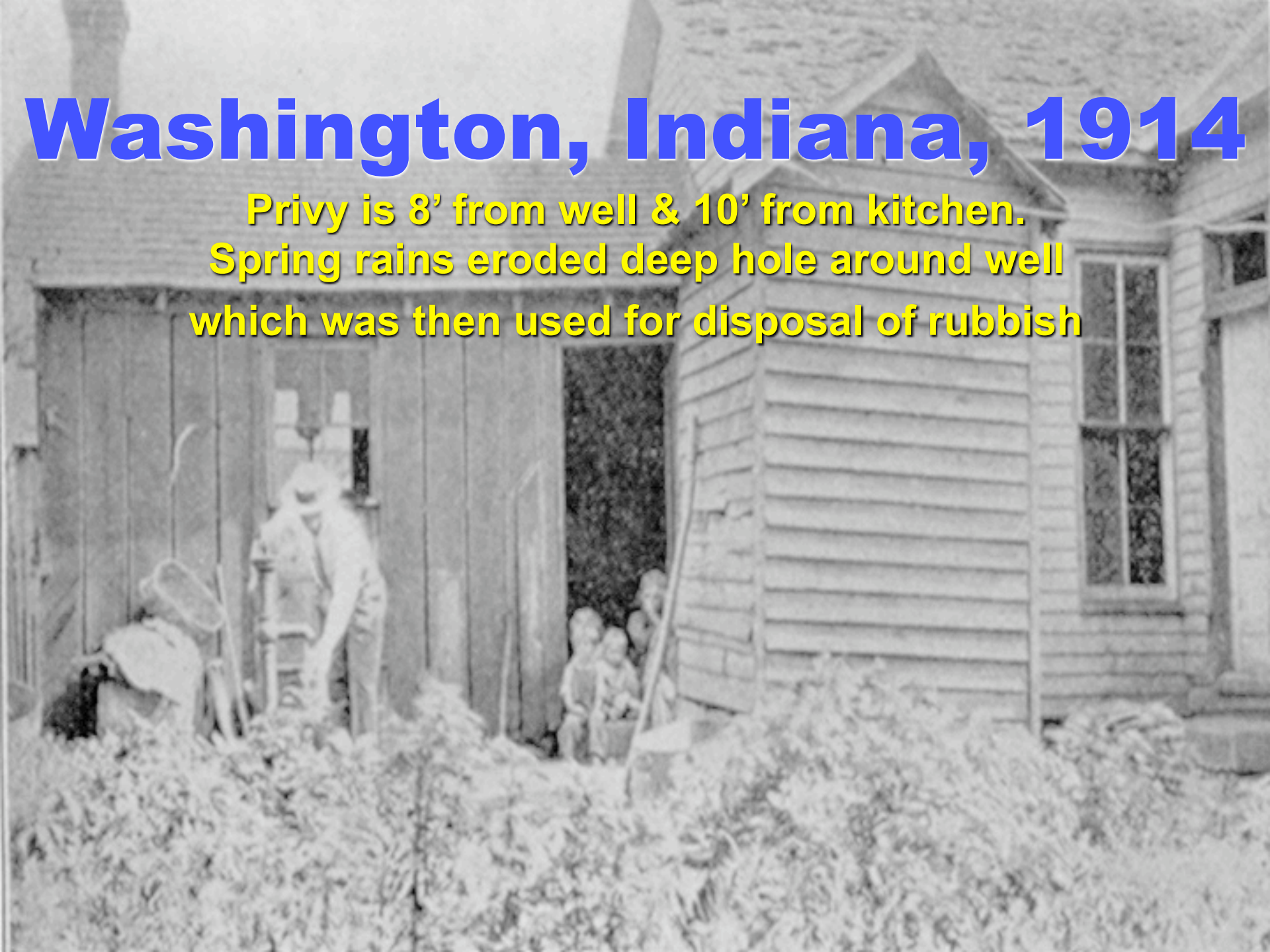
Washington, Indiana, 1914
Privy is 8’ from well & 10’ from kitchen.
Spring rains eroded deep hole around well
which was then used for disposal of rubbish

Sears Catalogs, Rags, Newspapers & Corn Cobs

packaged toilet paper,
first introduced in 1857,
sold poorly.

Scott paper on a roll
succeeded in 1890.

2000: 150 rolls/yr,
$40 / person

scented, recyclable

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Southeast Missouri Farms Project

1938

laborers construct, load outhouses for delivery to Missouri homesteads

Privy with a View

On August 29, 2007, the highest outhouse in the continental U.S., atop Mount Whitney, was removed. Two other outhouses, in the Inyo National Forest, were closed due to the expense and danger involved in transporting out large sewage drums via helicopter.

Alaska 2010

Outhouse Capital of the United States

"Ventilation?

Every Outhouse in Alaska has bullet holes ..."

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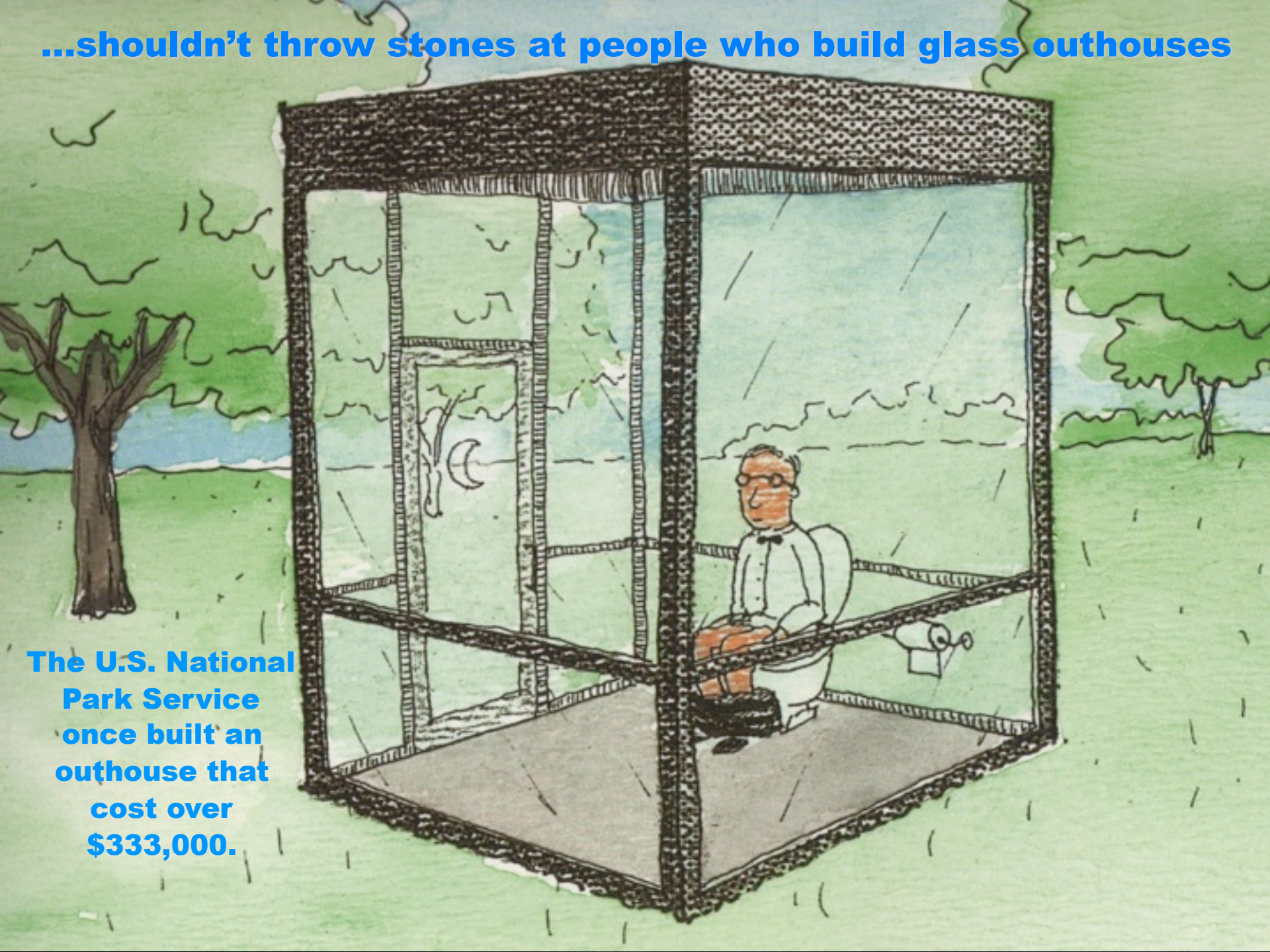
Wasilla, Alaska Outhouse

New Zealand 2004 - Loo with a View

SUPER
LOO
SUPER
LOO

...shouldn't throw stones at people who build glass outhouses



The U.S. National Park Service once built an outhouse that cost over $333,000.

U.S. Population becomes Urban

1910: 92 million

38% sewered

89% untreated

1968: 197 million

70% sewered

89% treated

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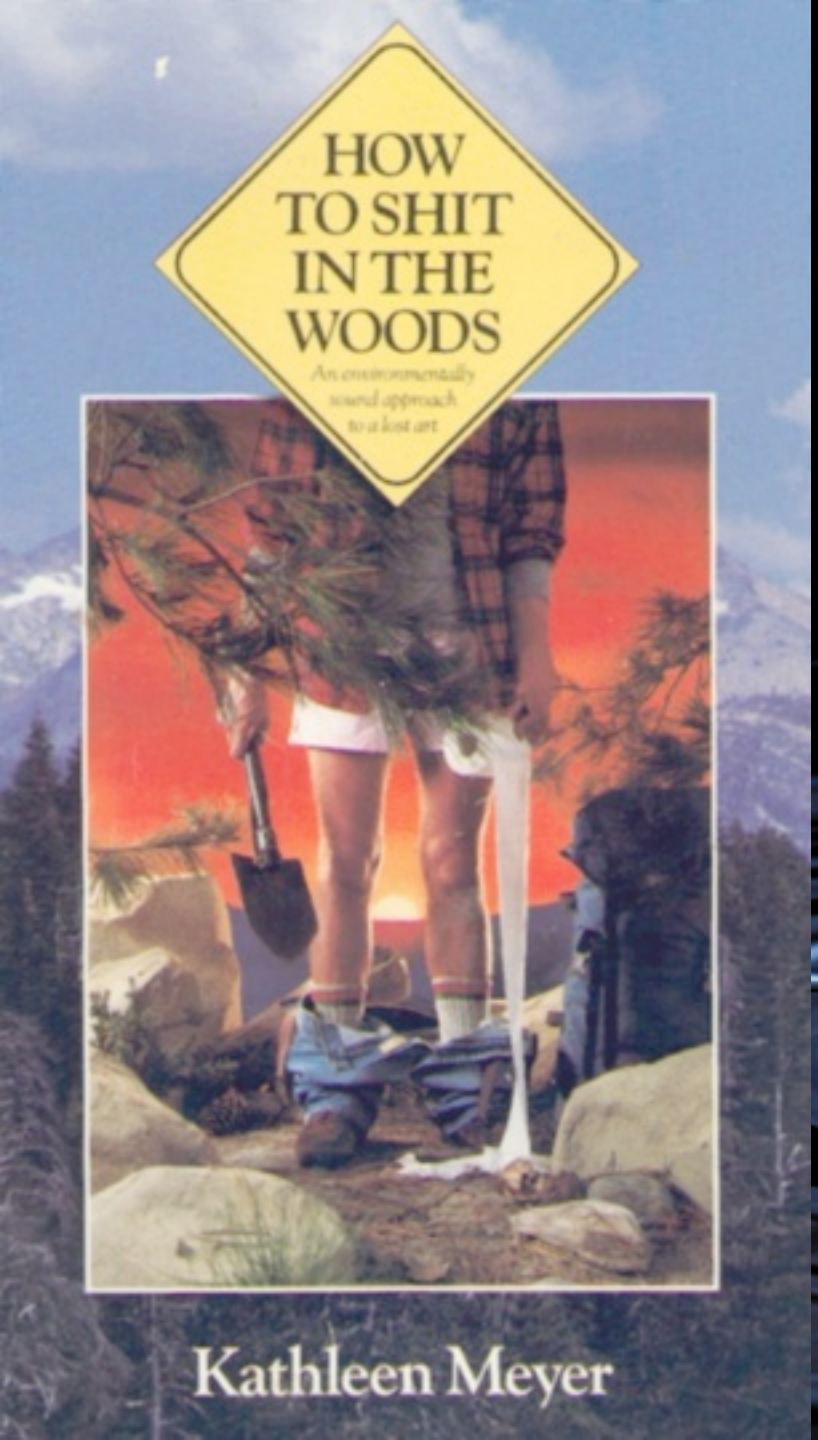

How quickly we forget!

2001: Enlightening The Trekker

Dig a Hole

Plastic Bag as Chamber Pot

Don't Use the Flora

Pack out the Paper

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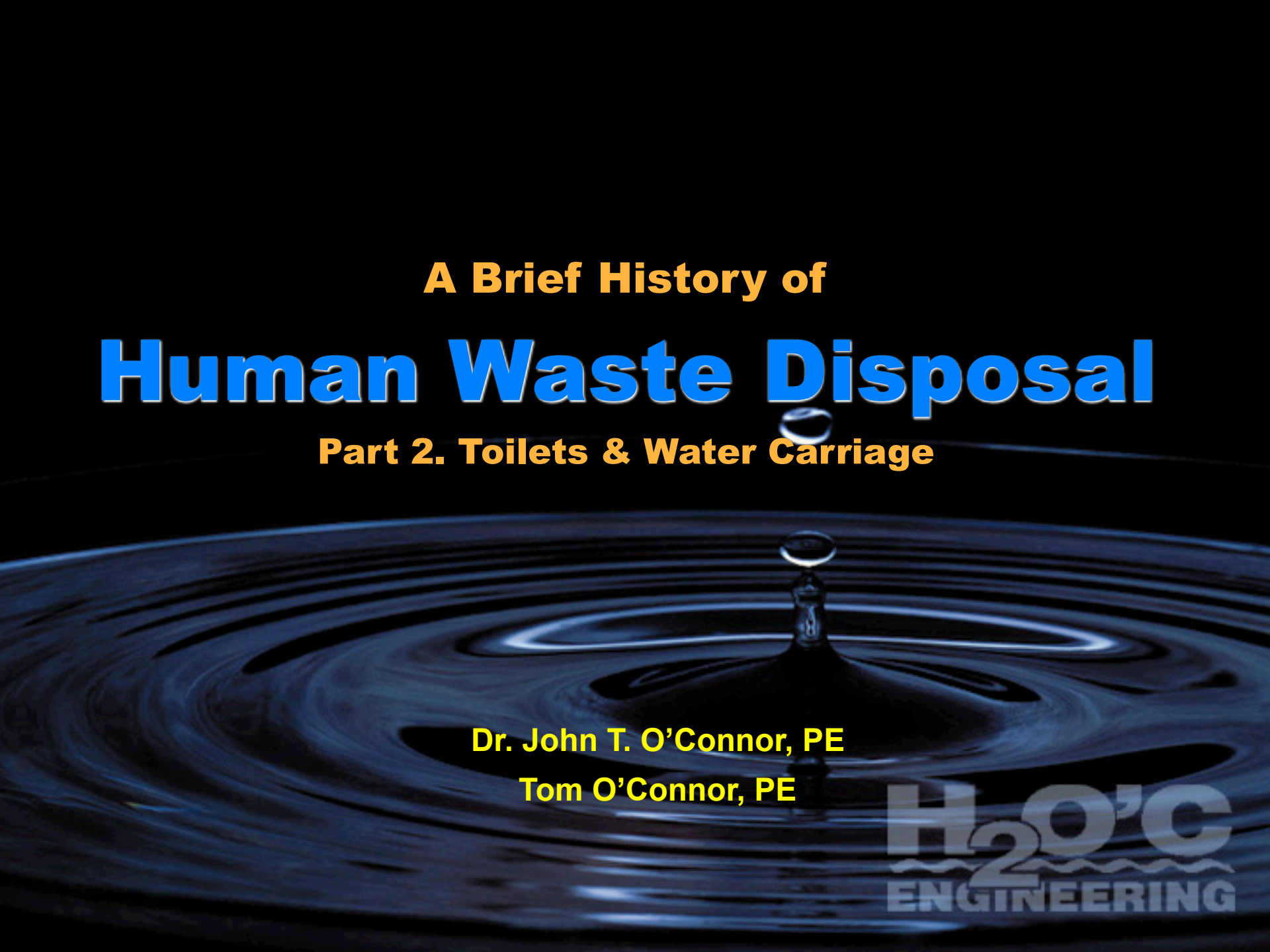
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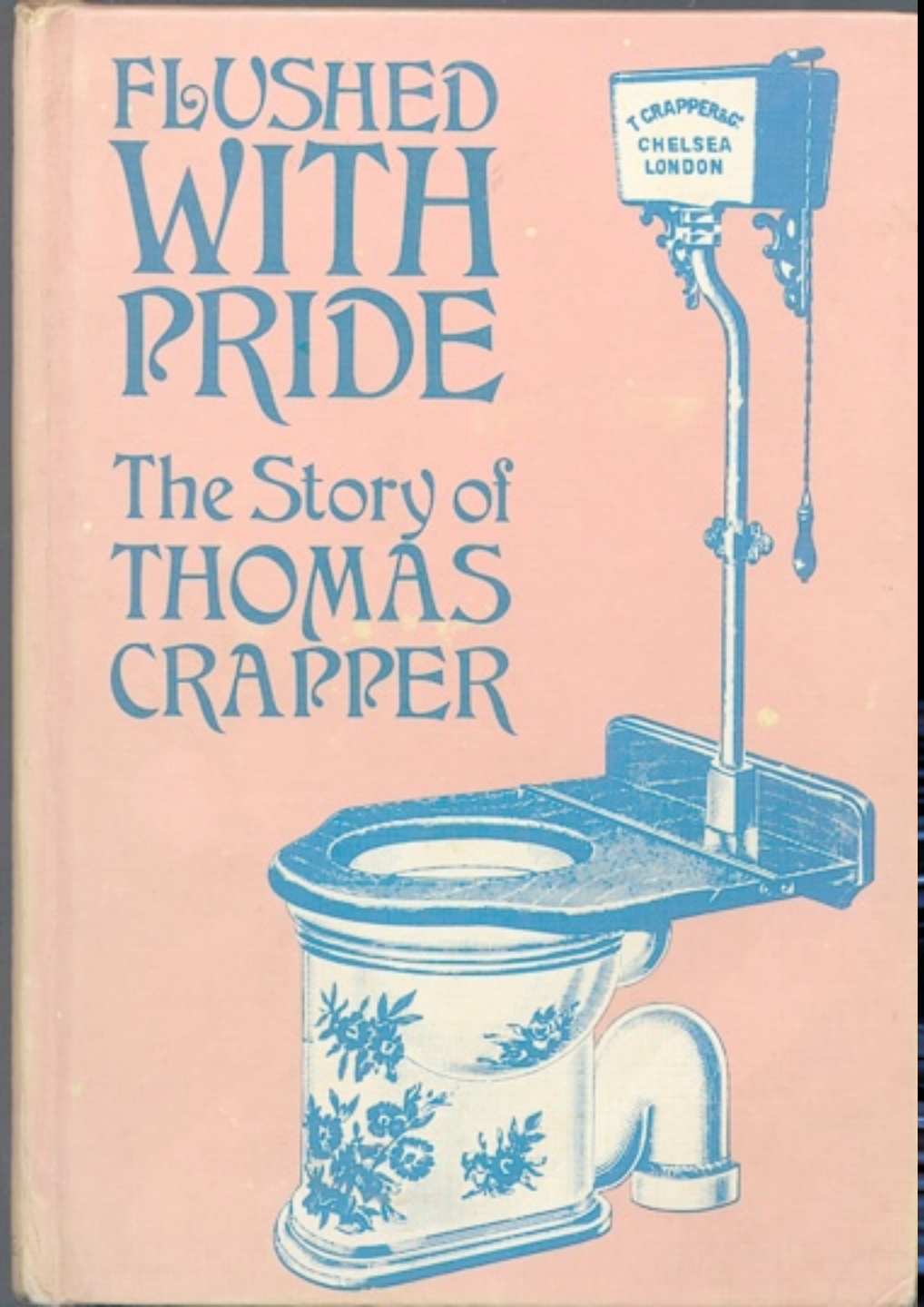
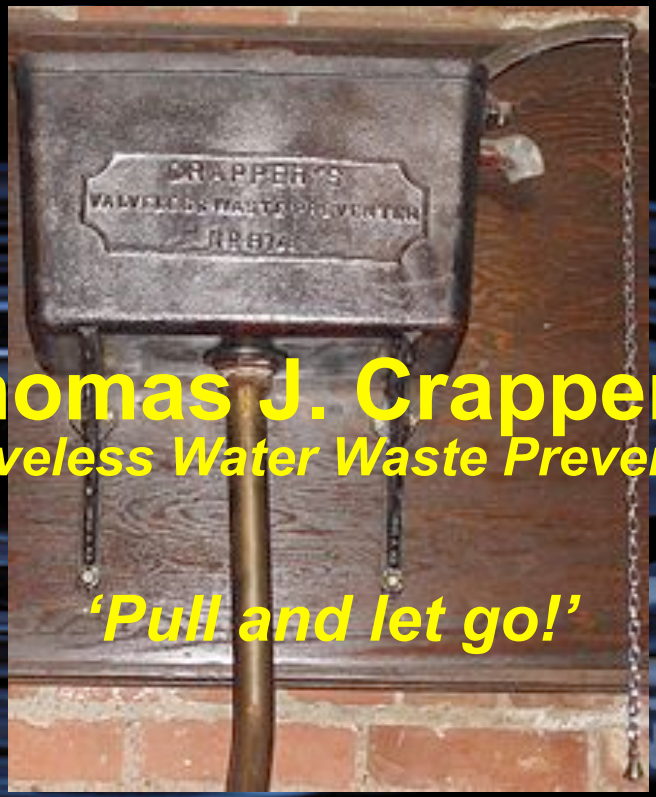


Indoor Plumbing
circa 1900

to eliminate:
disease, fumes, explosions



Thomas J. Crapper's
Valveless Water Waste Preventer

'Pull and let go!'

Telegrams CRAPPER CHELSEA Telephone No. 357 Kensington

THOMAS CRAPPER & CO.,

PATENTEES AND MANUFACTURERS

OF

Sanitary Appliances.

ENGINEERS BY APPOINTMENT TO

His Majesty the King

AND

H.R.H. The Prince of Wales.

MARLBORO' WORKS, CHELSEA, LONDON, S.W.

Show Rooms and Offices:

50, 52, & 54 MARLBOROUGH ROAD, CHELSEA, S.W.

CATALOGUE AND PRICE LIST,

MAY, 1902.

(Subject to alterations without notice.)

ALL PREVIOUS ISSUES CANCELLED.

0-13-322560-7

T. Crapper, Sanitary Engineer also patented:

House Drain Ventilators

Air Pump and Smoke Generating Machines

Disconnecting Traps

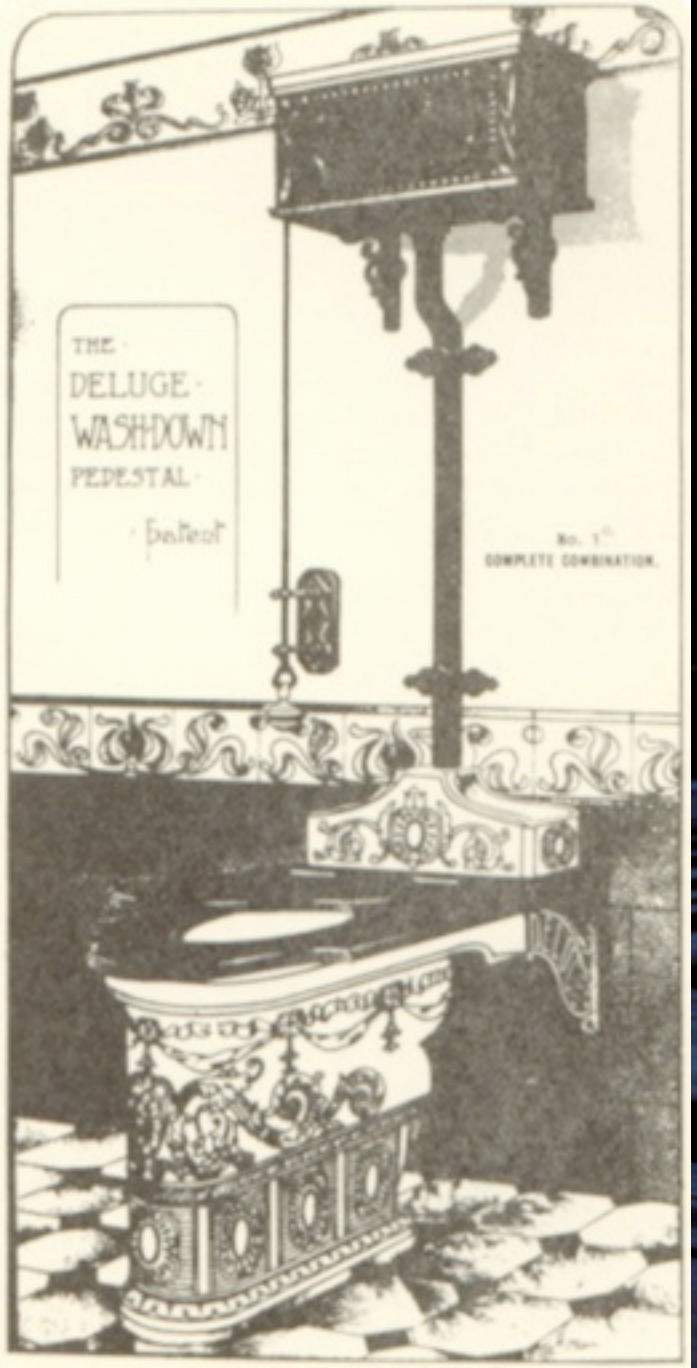
Self-Rising Closet Seats

Cantilever Toilet

Flusherette Valve

Stair Treads to prevent slipping

H2O'C ENGINEERING



An early Twyford W.C. with siphonic cistern

Explosions, Rats & Disease

1870: 1 in 3000 died of typhoid

Waterborne Wastes required Collection Systems (Sewers)

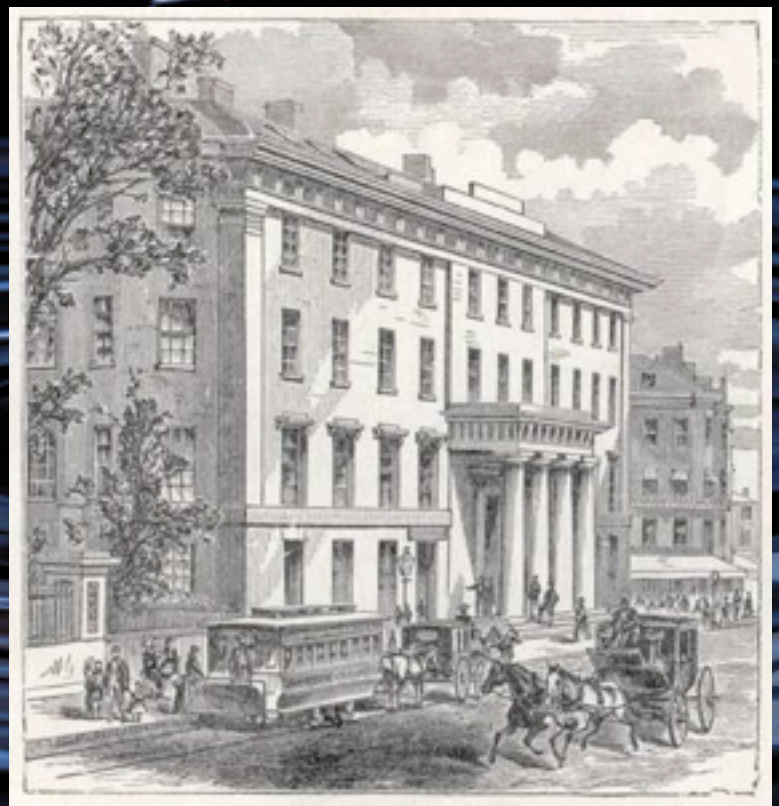
Toilets Undermined Use of Cesspools

H2O'C ENGINEERING

Earliest Indoor Plumbing United States

White House: 1825 – the ‘Quincy’

Tremont House (Boston Hotel): 1880s



Toilet Paper - U.S.

1857 Joseph Gayetty - therapeutic paper with Aloe

500 sheets for 50¢

1890 Scott Paper Co. - tissue on a roll -1000 sheets

"over 65% of middle-aged men and women suffer from some sort of rectal disease"

"Sani-tissue and Waldorf are famous bathroom tissues specifically processed to satisfy the three requirements doctors say toilet tissue must have to be safe: absorbency-softness-chemical purity"

H2O'C ENGINEERING

Hello, Toto

‘Faulty wiring’ leading to smoke and fires prompted Toto, Japan’s leading toilet maker, to offer free repairs on 180,000 of their popular series Z electric bidet toilets.

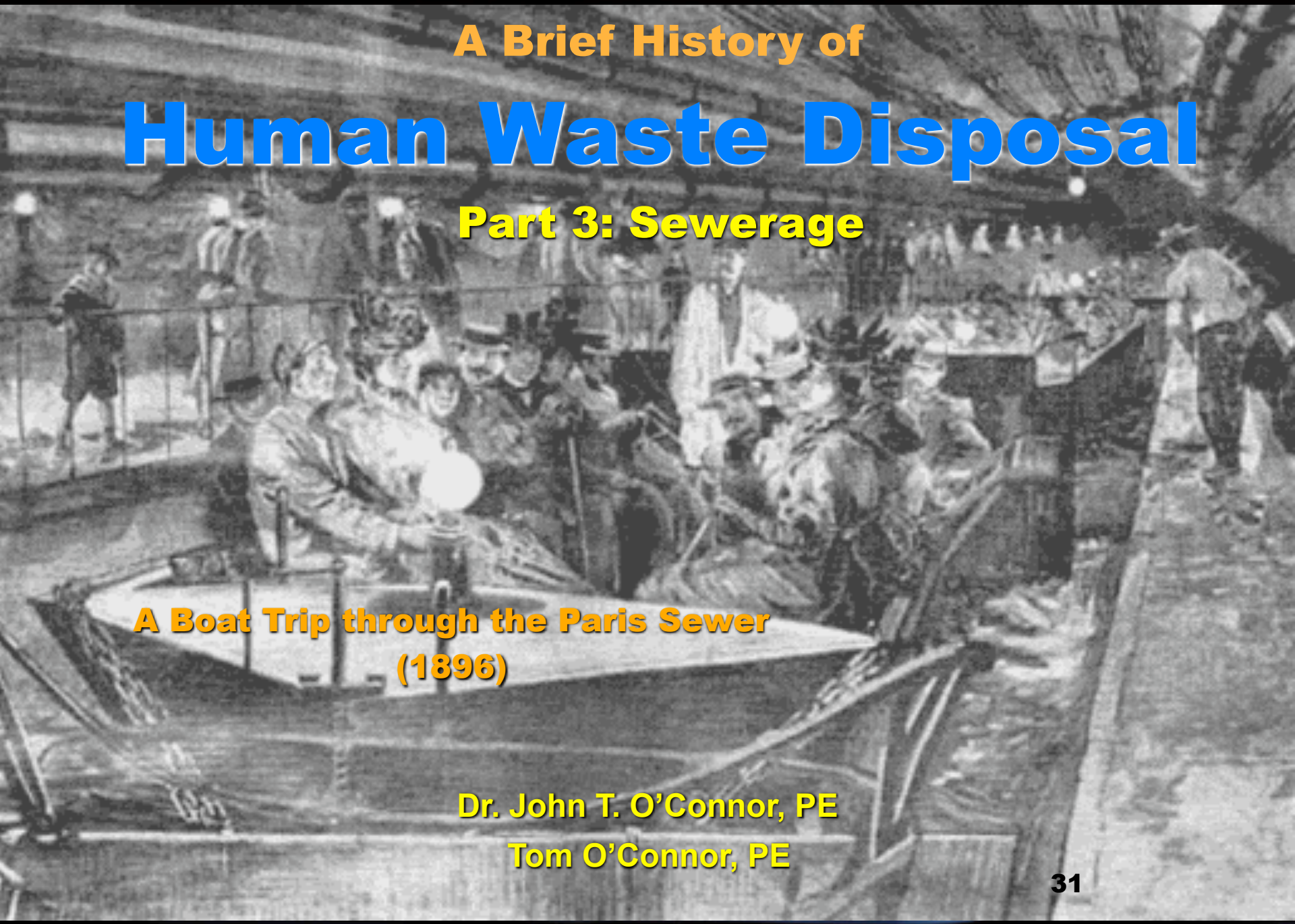
The $2,000 “Z” features a pulsating massage spray, a power dryer, built-in-the-bowl deodorizing filter, a ‘Tornado Wash’ flush and a lid that opens and closes automatically.

BanZai!

A Brief History of

Human Waste Disposal

Part 3: Sewerage



A Boat Trip through the Paris Sewer
(1896)

Dr. John T. O'Connor, PE
Tom O'Connor, PE

Sewer Socialists?

"Municipal Socialism" 1900-today

A Century of Sewer Construction in the U.S.:

- **disposal of wastes to sewerage found *'convenient'***
- **ample *water supplies* led to production of ever-increasing volumes of *'wastewater'***

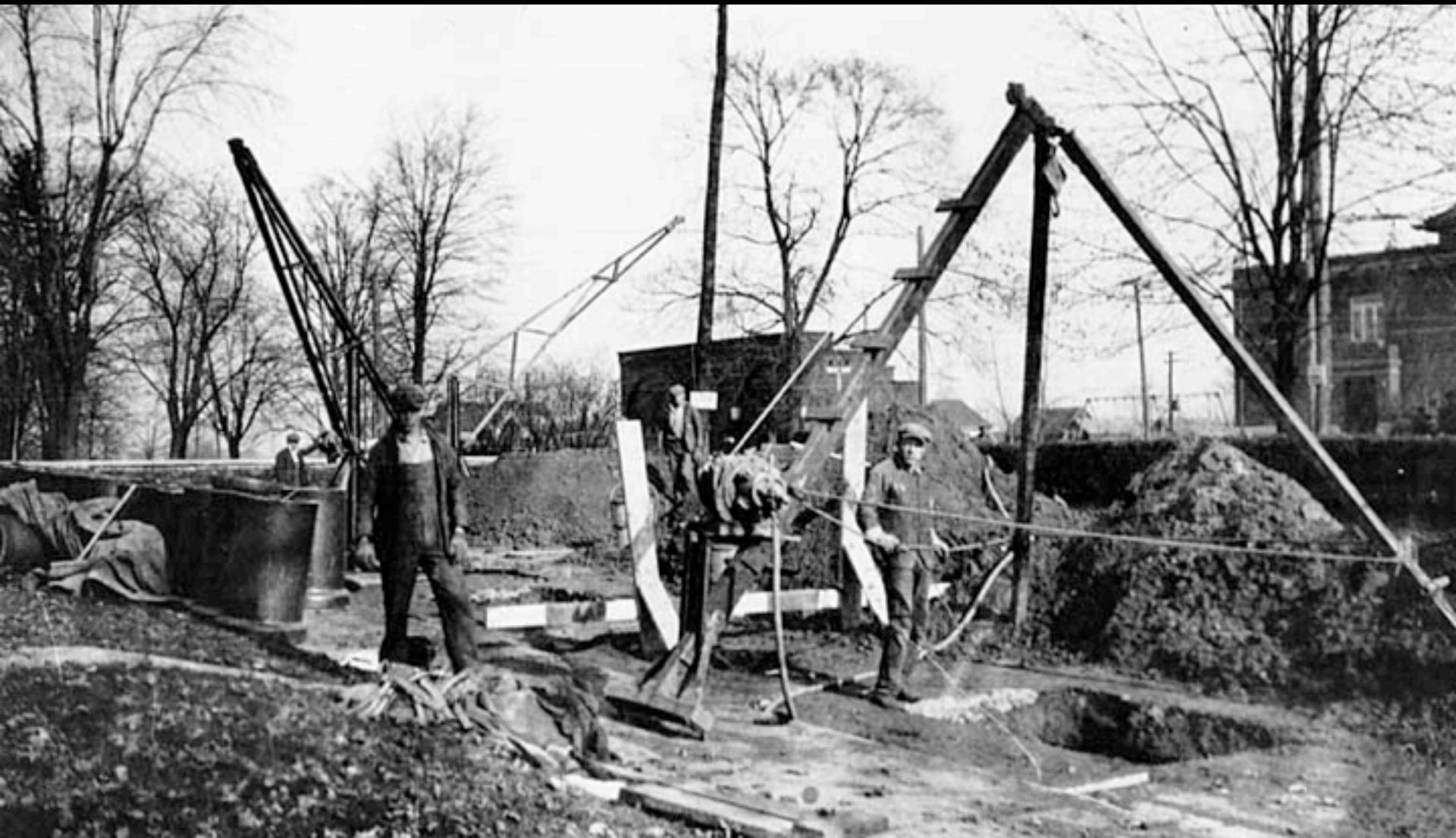
H2O'C ENGINEERING

Bristol, England

Hollowed-Out Wooden Water Pipe - 500 years old

Museum of Edinburgh, Scotland

Sewer Construction - 1900



Salt Lake City to Sewer Farms 1908

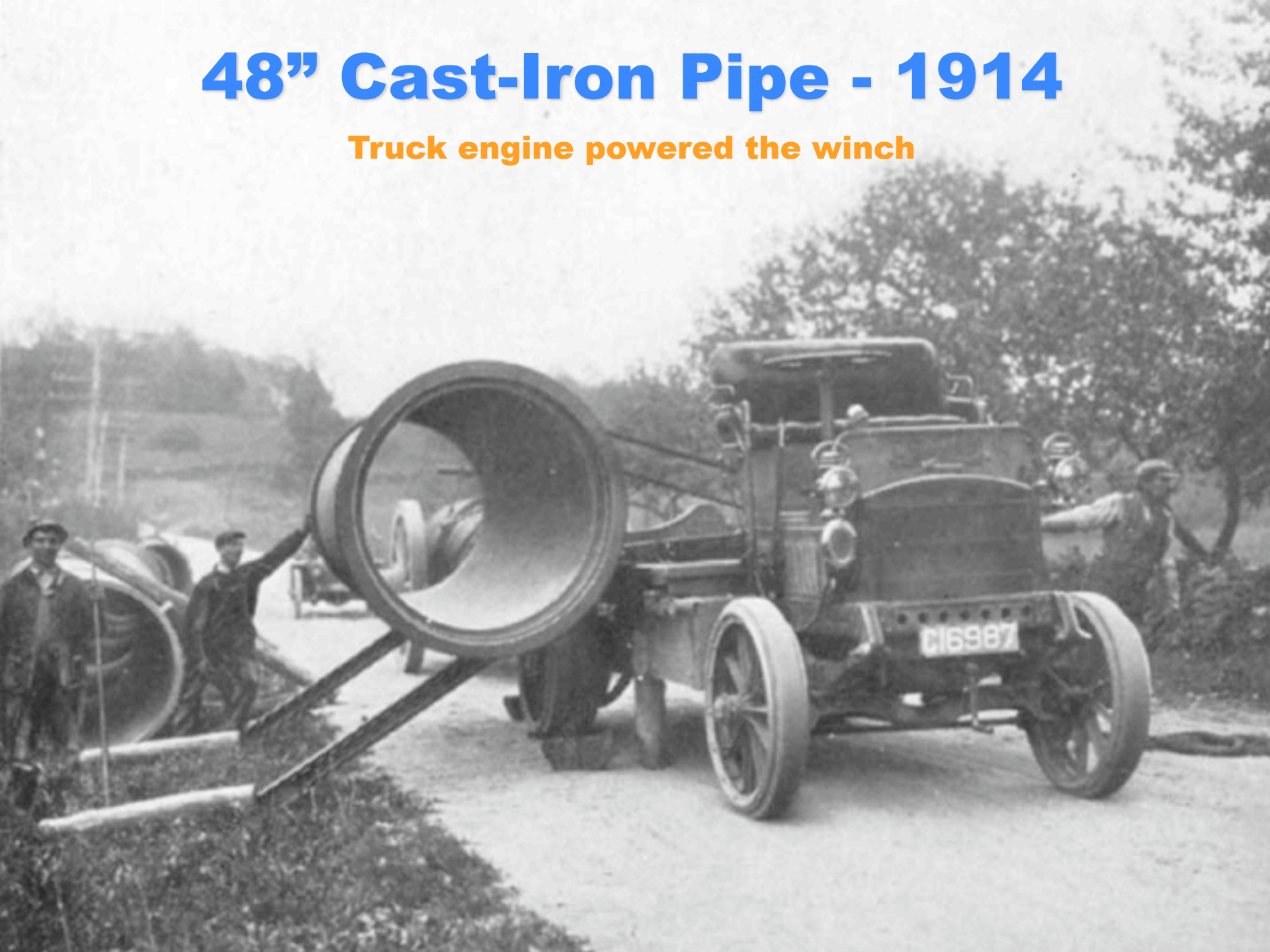
Wood Stave Pipe assembled in the trench

Sewer Construction 1900

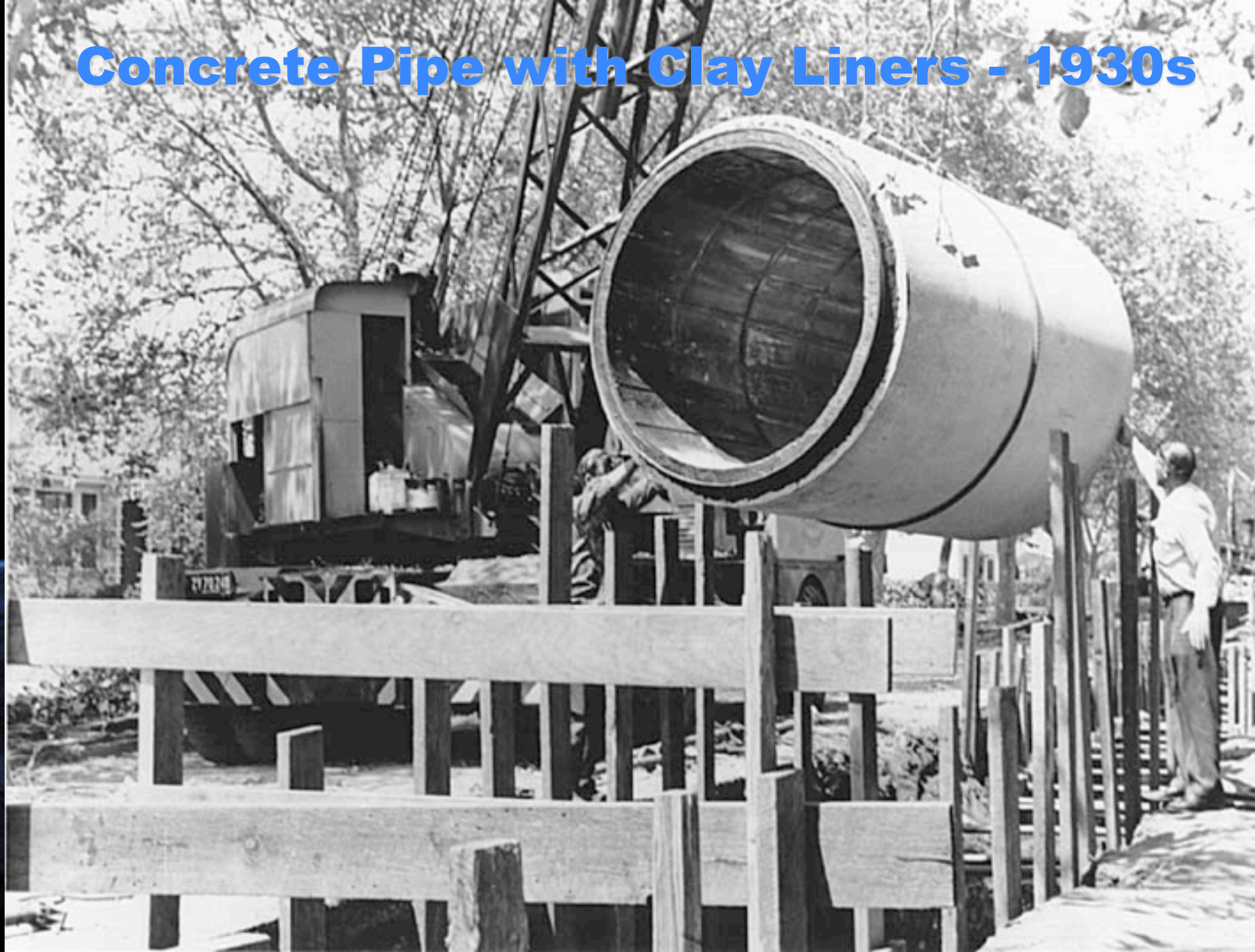
Joske's
PAP

48” Cast-Iron Pipe - 1914

Truck engine powered the winch



Concrete Pipe with Clay Liners - 1930s



Springfield, Missouri

Sanitary Sewerage Timeline

1894-1910: 41 miles - brick and clay sewers

1911-1937: 96 miles

1937-1957: 68 miles - clay pipe

1960 - vitrified clay, cast iron, rein. conc. pipe

1976 - polyvinyl chloride pipe

2010: 1,176 miles + *25 miles/year*

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Separate Sewer System

Combined Sewer System

Combined or Separate Sewers?

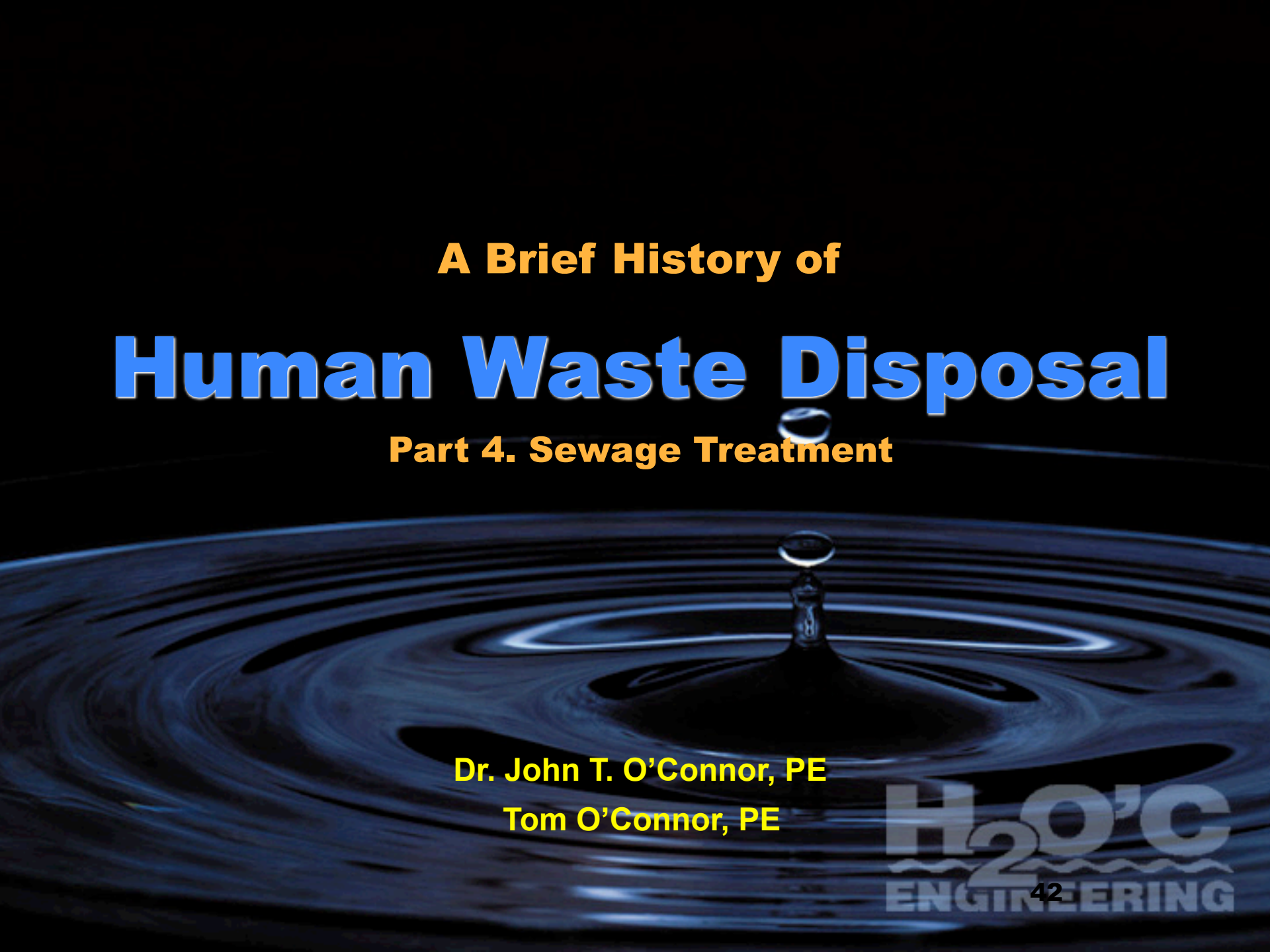
In the older parts of Kansas City, the same pipe that carried stormwater also carried sewage in a *Combined Sewer System.*

Combined Sewer Systems were common until the 1970s as wastes were simply carried to streams.

Combined Sewers were constructed because sewage treatment was not anticipated. It was thought to be more economical to build one pipe rather than two.

Costly choice, as it turns out. **Kansas City will spend $2.5 billion over 25 years to curb unauthorized overflows of untreated raw sewage.**

U.S. has ≈600,000 miles of publicly-owned sewer pipe



A Brief History of

Human Waste Disposal

Part 4. Sewage Treatment

Dr. John T. O'Connor, PE

Tom O'Connor, PE

H2O'C ENGINEERING

Unsewered Systems

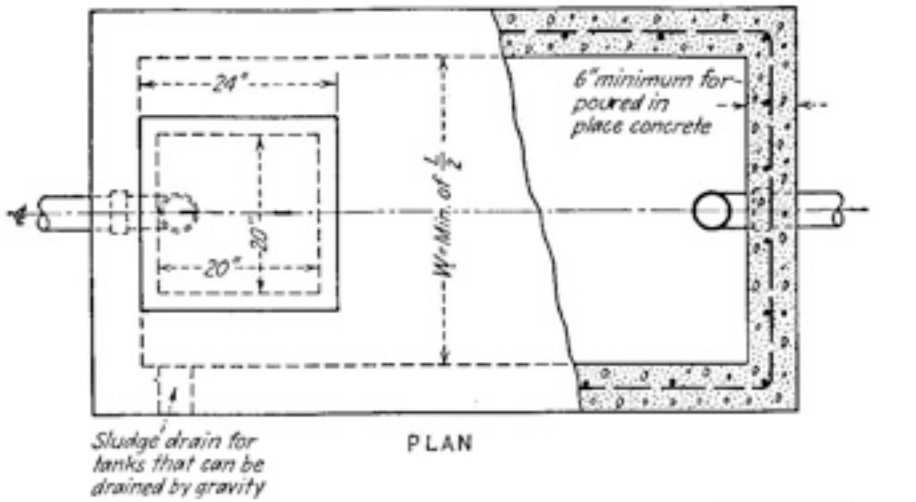
On-Site Treatment and Disposal:

Flow Range: 0.2 to 2 m^3/ day

Septic Tanks (Settling; Fermentation):

- 1 to 2 day retention; 2 meters deep
- scum, sludge removal every 6 to 12 months
- sludge to lagoons, earth-covered trenches
- *or* plowed into land after partial drying on surface
- soil absorption systems for tank overflow

H2O'C ENGINEERING



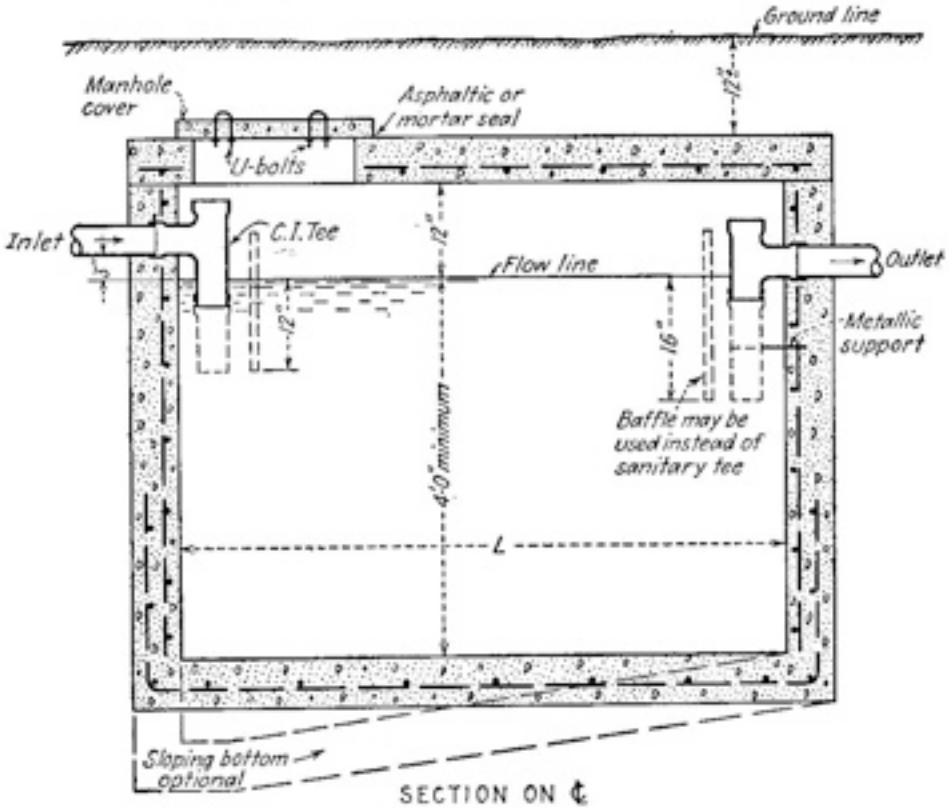


FIG. 51. A single-compartment septic tank.

Septic Tank

Unit Capacity:

4 to 16 people

500 - 2000 gallons

90 -300 cubic feet

1-3 compartments

L/W: 3/1; D: 4-6 ft.

Scum, gas baffles

Filter Vault

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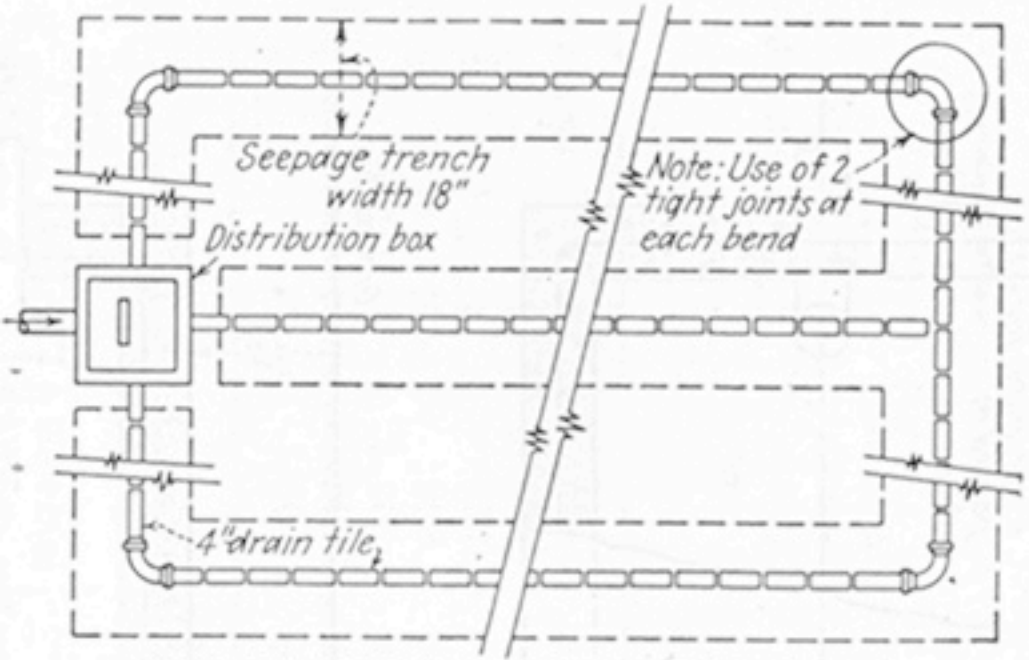
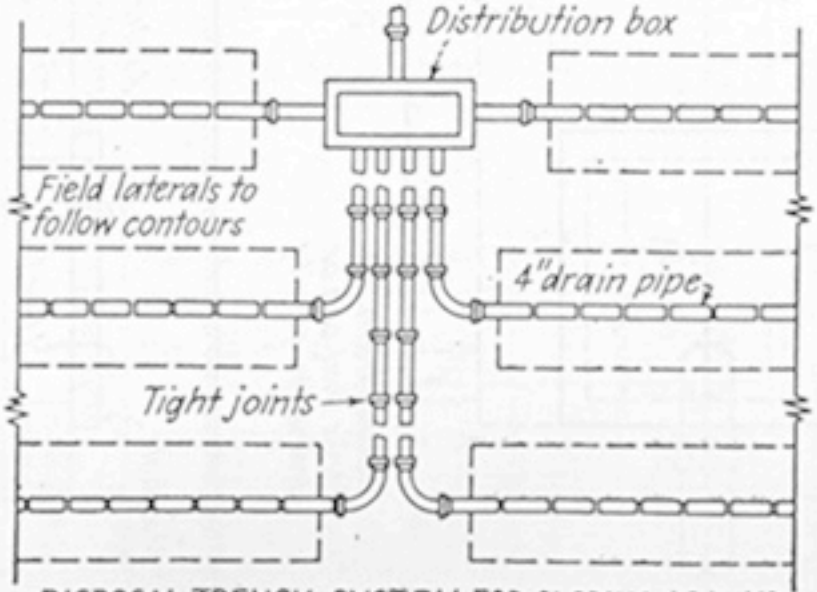


DISPOSAL TRENCH SYSTEM FOR LEVEL GROUND



DISPOSAL TRENCH SYSTEM FOR SLOPING GROUND

Tile Fields

Sub-Surface Disposal

Gravel-filled Trenches

Open-Joint Tiles

Infiltration to Vadose Zone

Biological Slime Formation

Mineral Precipitates, FeS

Release of Gases, H_2S, CH_4

Soil Acceptance Rate:

0.3 to 0.5 gpd/sf

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Sewage Disposal - 1930

U.S. Sewage Disposal (Cities > 100,000 Population)

"Dilution is the Solution to Pollution"

Treatment	Population	%
None, Dilution alone	16,900,000	46.4
Fine Screening, Dilution	8,500,000	23.3
Sedimentation, Dilution	5,700,000	15.6
Trickling Filtration, Dilution	*2,500,000*	*6.9*
Activated Sludge, Dilution	*2,600,000*	*7.1*

14% of population of major cities had biological treatment.

H2O'C ENGINEERING

Karl Imhoff

1906: Taschenbuch der Stadtentwasserung

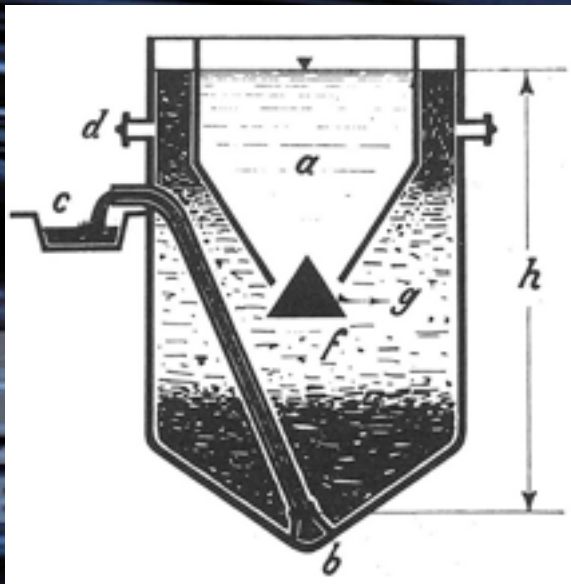
Sewers:Open ditches with concrete slabs

Two-Storied Settling and Digestion Tanks

1913-1934: 70 works constructed, Ruhr River

1929 : Karl Imhoff and Gordon Fair (Harvard)

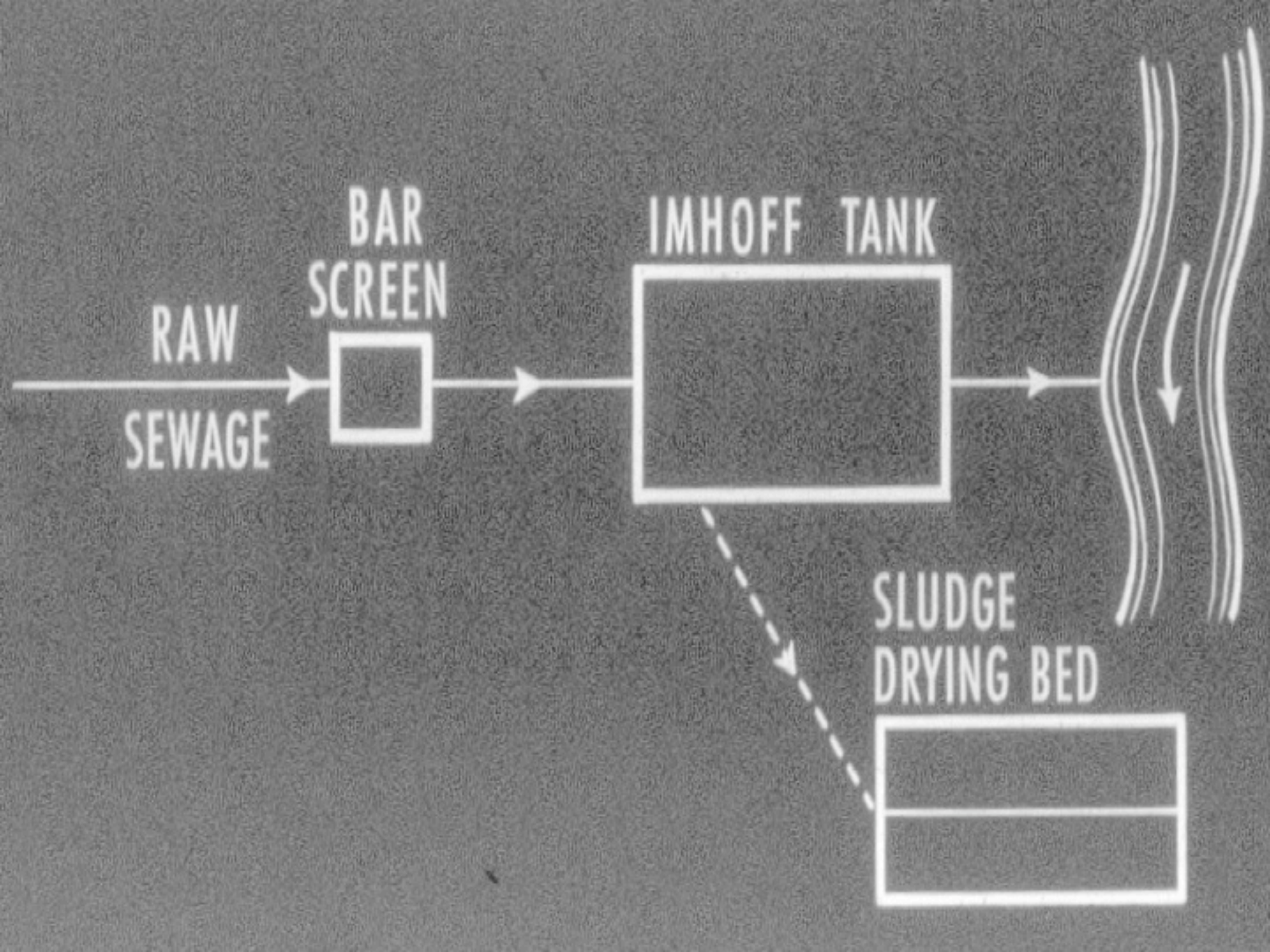
The Arithmetic of Sewage Treatment Works



Imhoff Tank patented in 1906; first operated in 1908

Imhoff Tank Treatment Plant

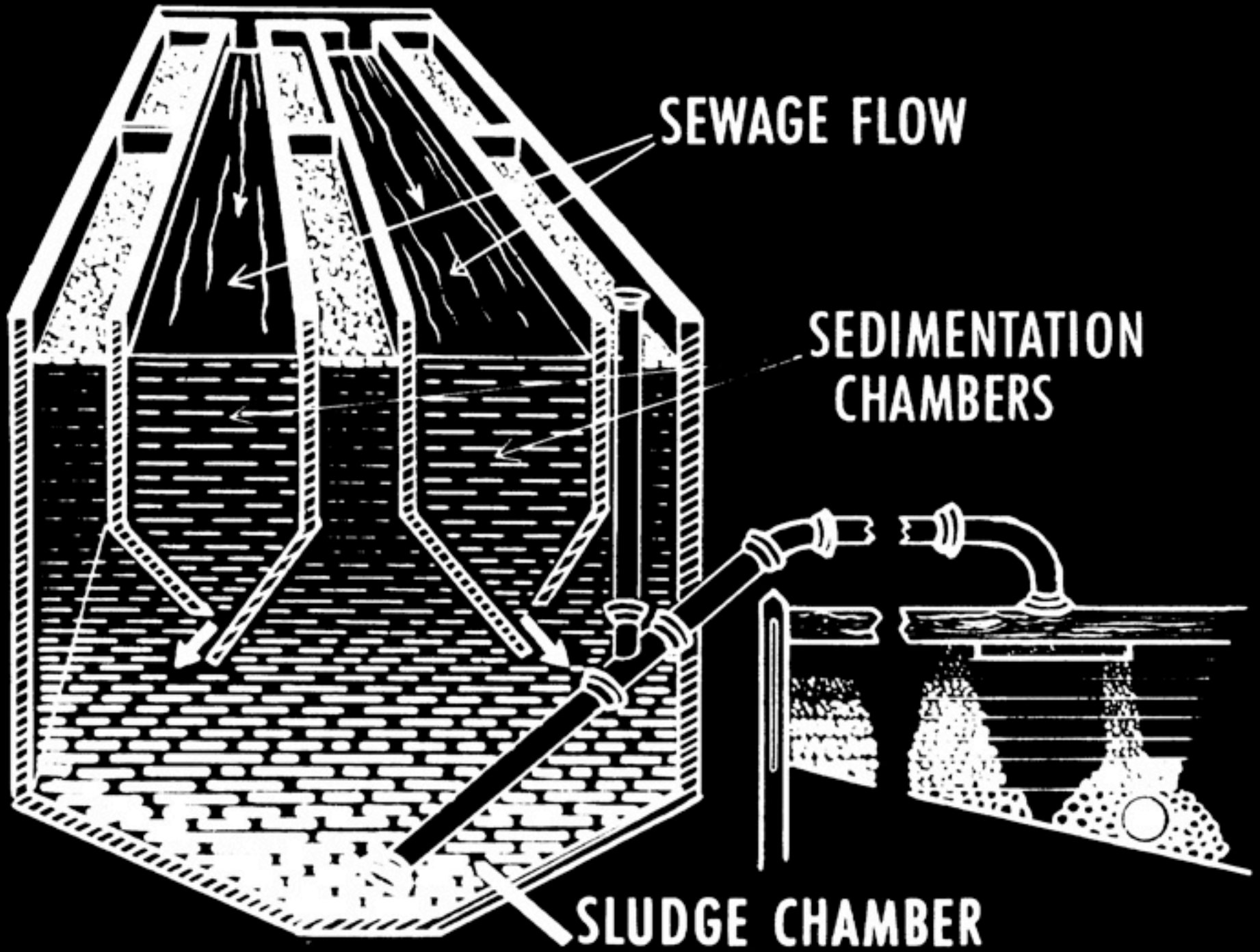
Population: 1000 **40,000 gpd**


RAW
SEWAGE
BAR
SCREEN
IMHOFF TANK
SLUDGE
DRYING BED

Manually-Cleaned Bar Rack

Imhoff Tank

Settling Compartments and Gas Vents


SEWAGE FLOW
SEDIMENTATION CHAMBERS
SLUDGE CHAMBER

Gas Rising from Gas Vent

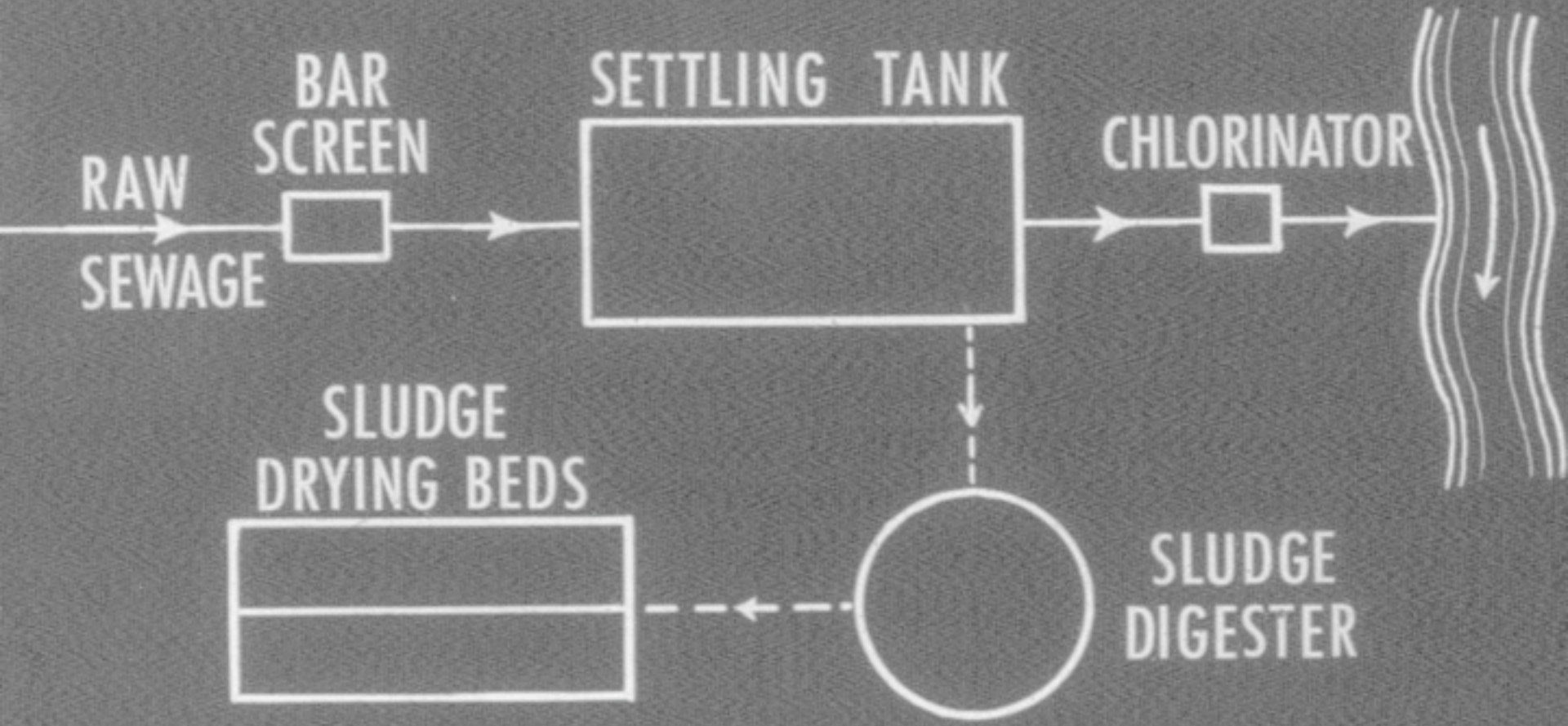
Raw Sludge Drying Beds

Sewage Effluent entering Stream

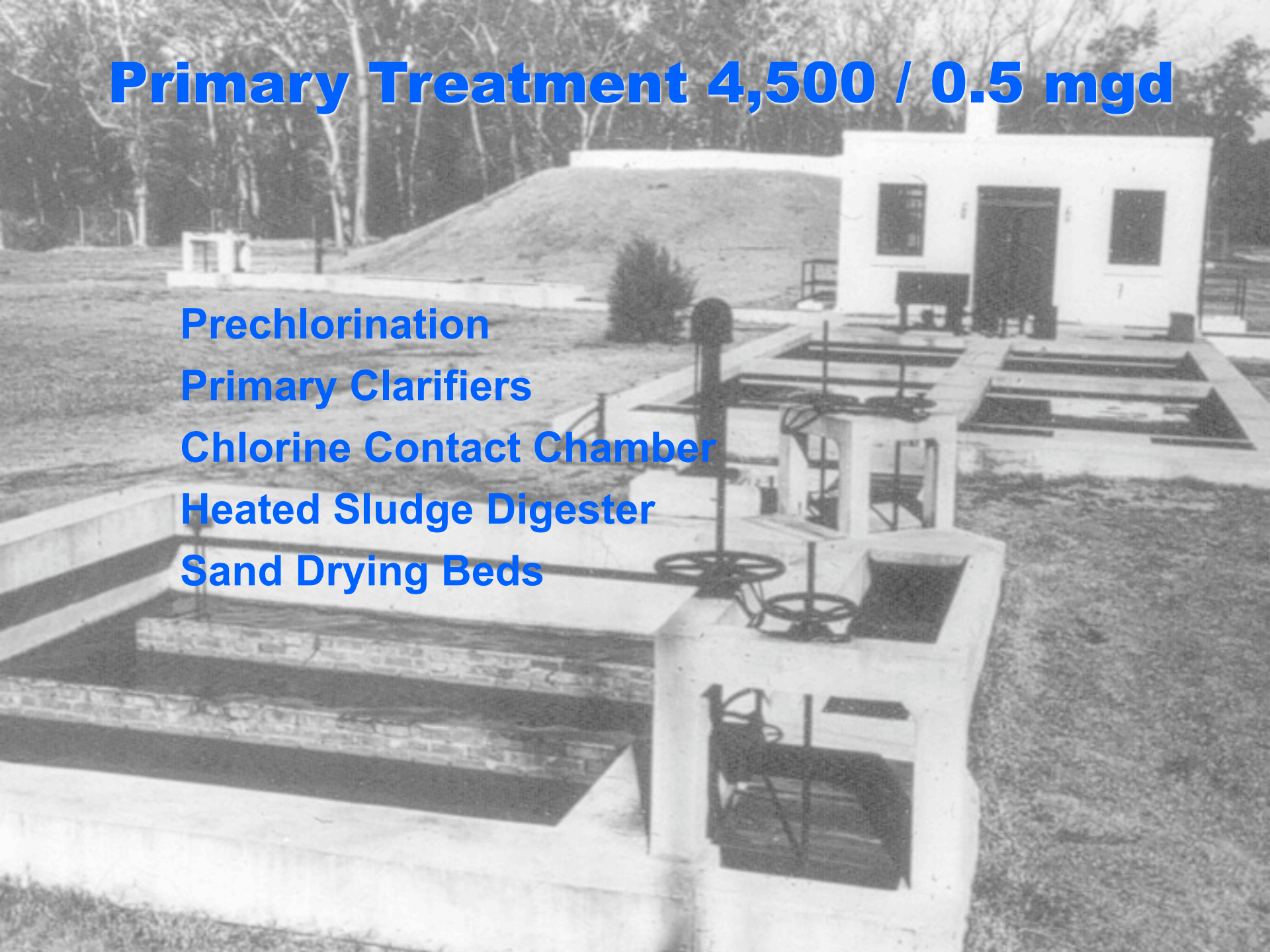
50% Suspended Solids Removal

50% Reduction in Oxygen Demand

PRIMARY SETTLING WITH SEPARATE SLUDGE DIGESTION



Primary Treatment 4,500 / 0.5 mgd



Prechlorination

Primary Clarifiers

Chlorine Contact Chamber

Heated Sludge Digester

Sand Drying Beds

Prechlorination and Sampling

Dual, Manually-Cleaned Bar Screens

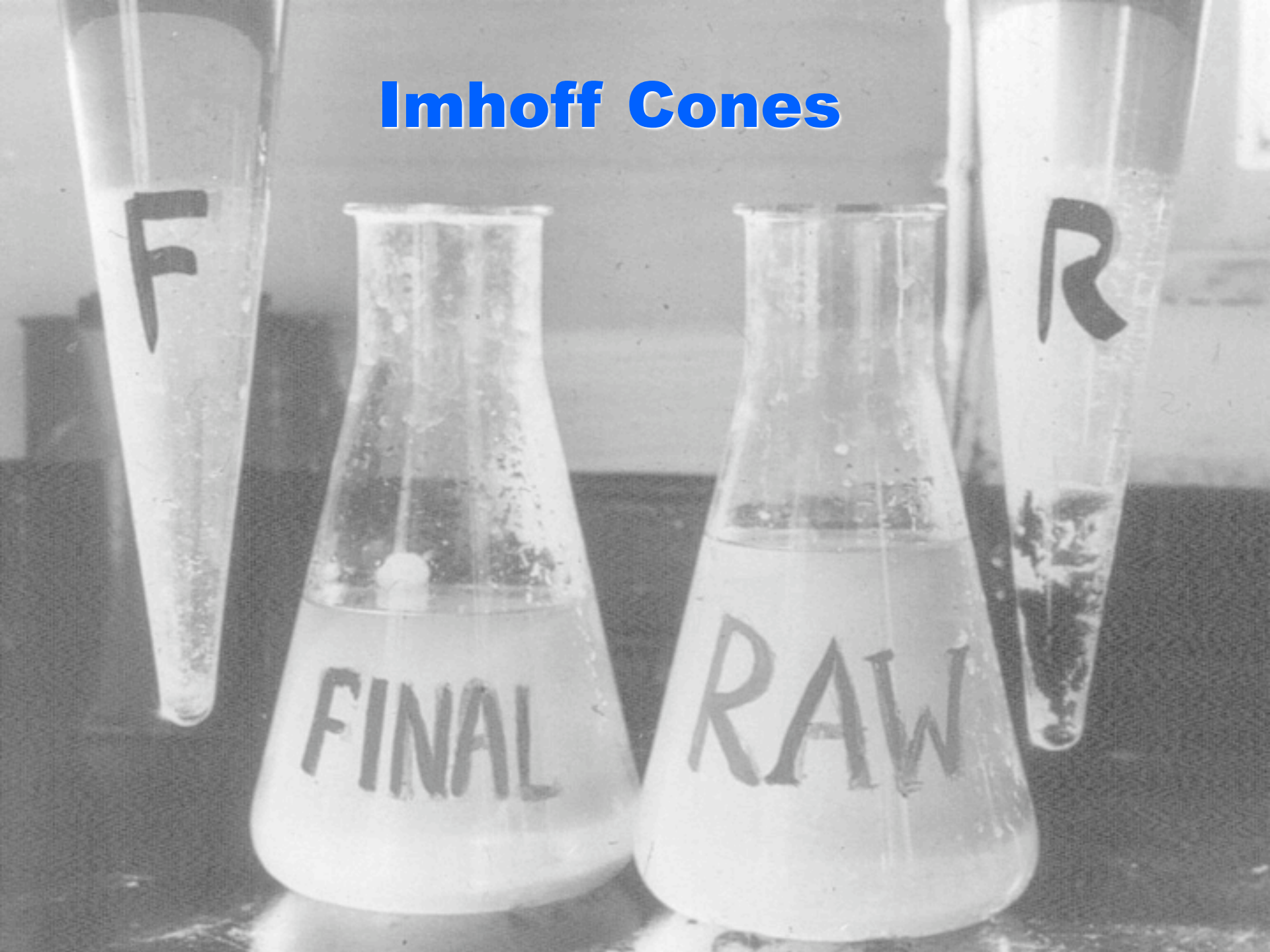
Rectangular, Mechanically-Cleaned Clarifiers

Scum Removal

Chlorine Contact Chamber

Effluent Sampling

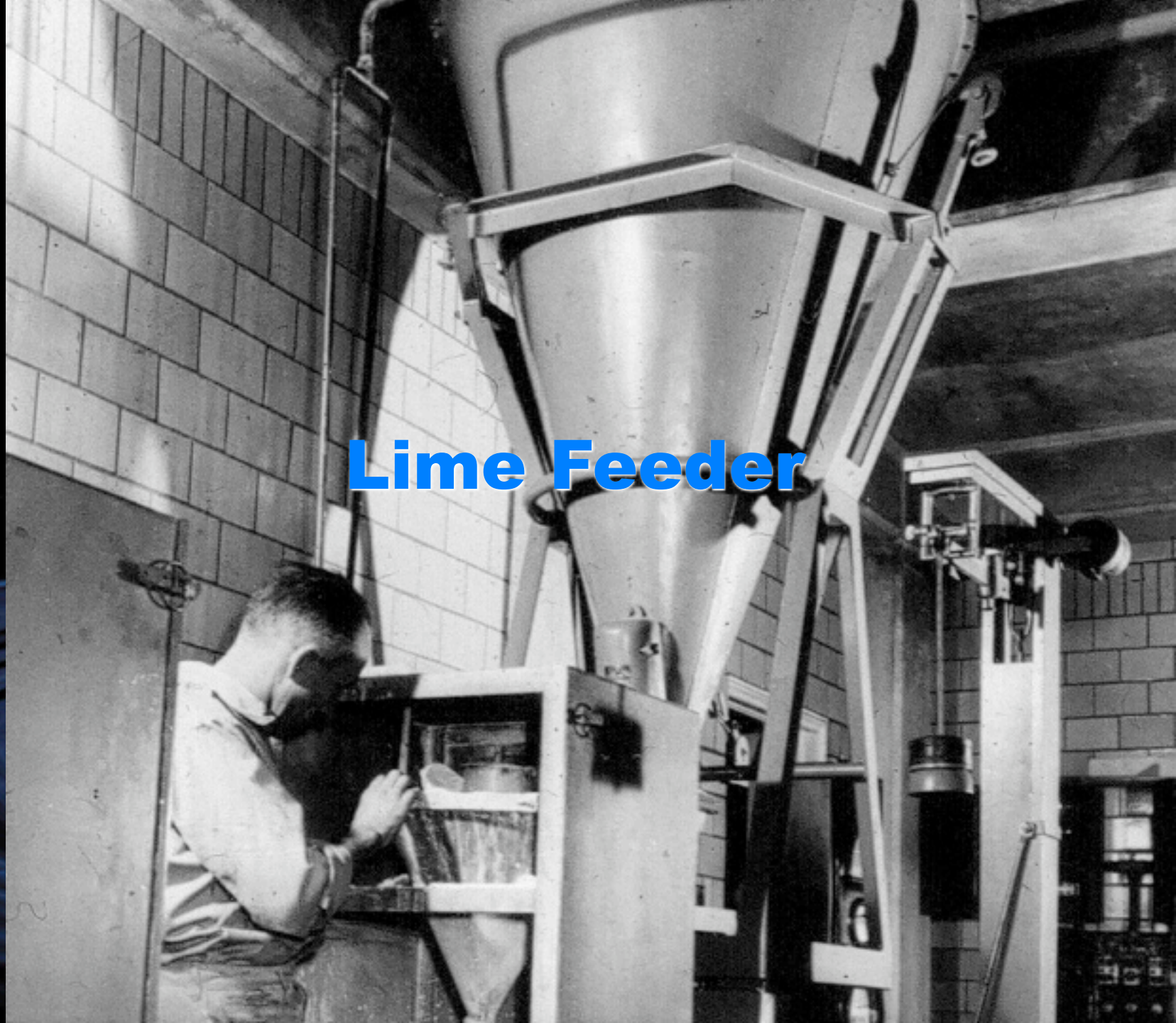
Imhoff Cones



Heated Digester

Floating Cover

Sand Drying Beds

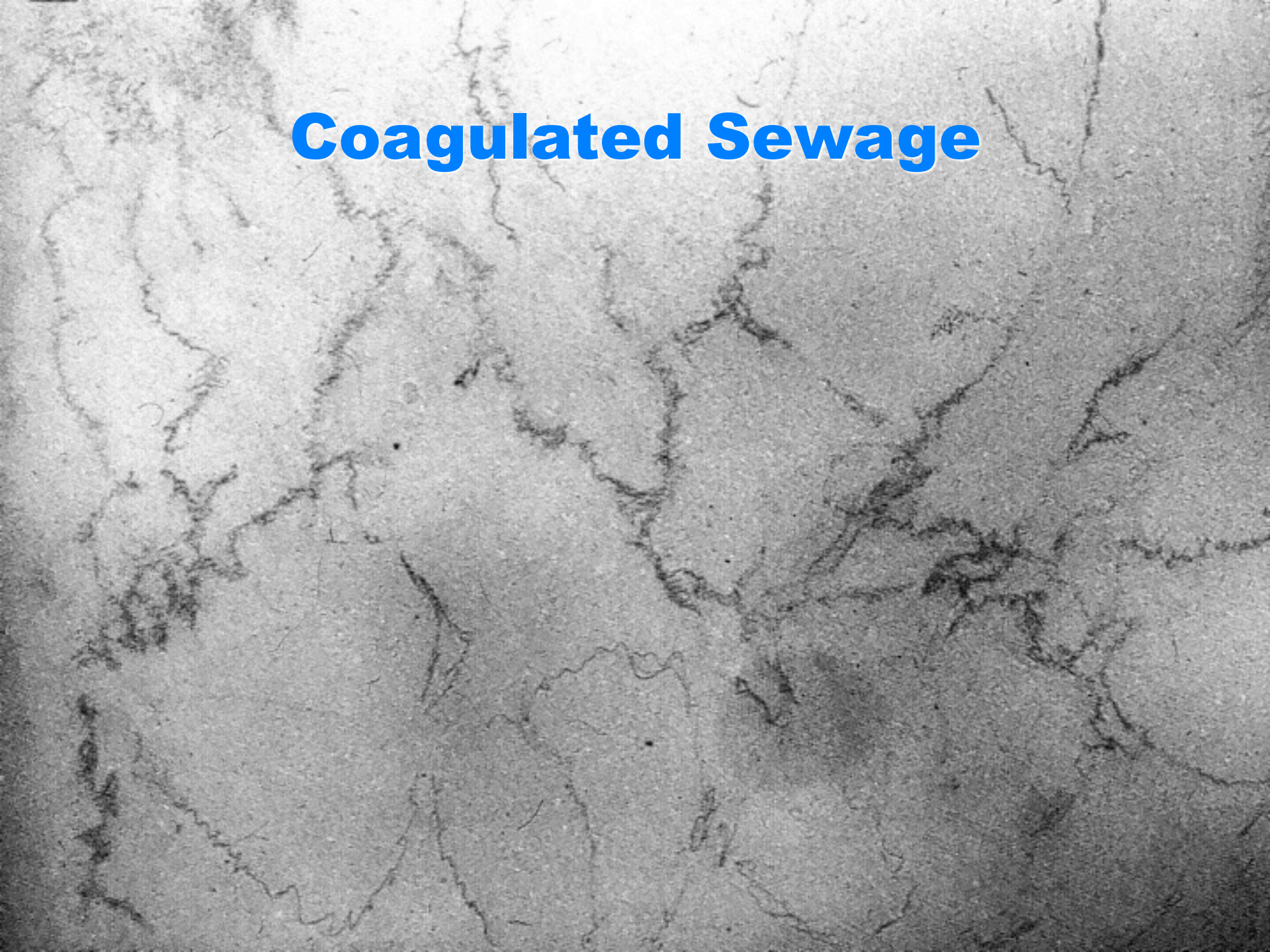

Lime Feeder

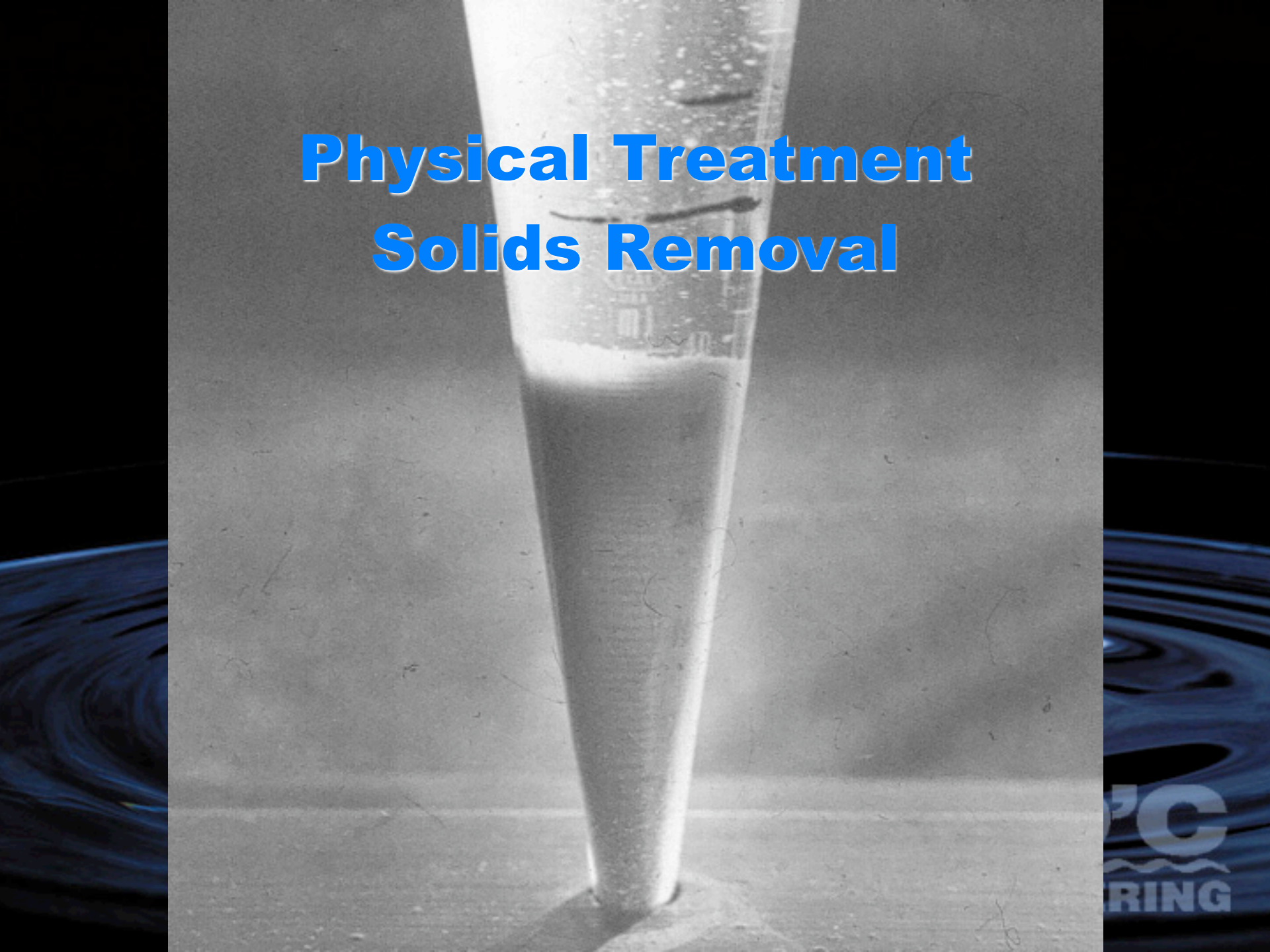
Lime Feed

Ferric Chloride

$FeCl_3$ + Lime Feed

Chemical Treatment Basin


Coagulated Sewage

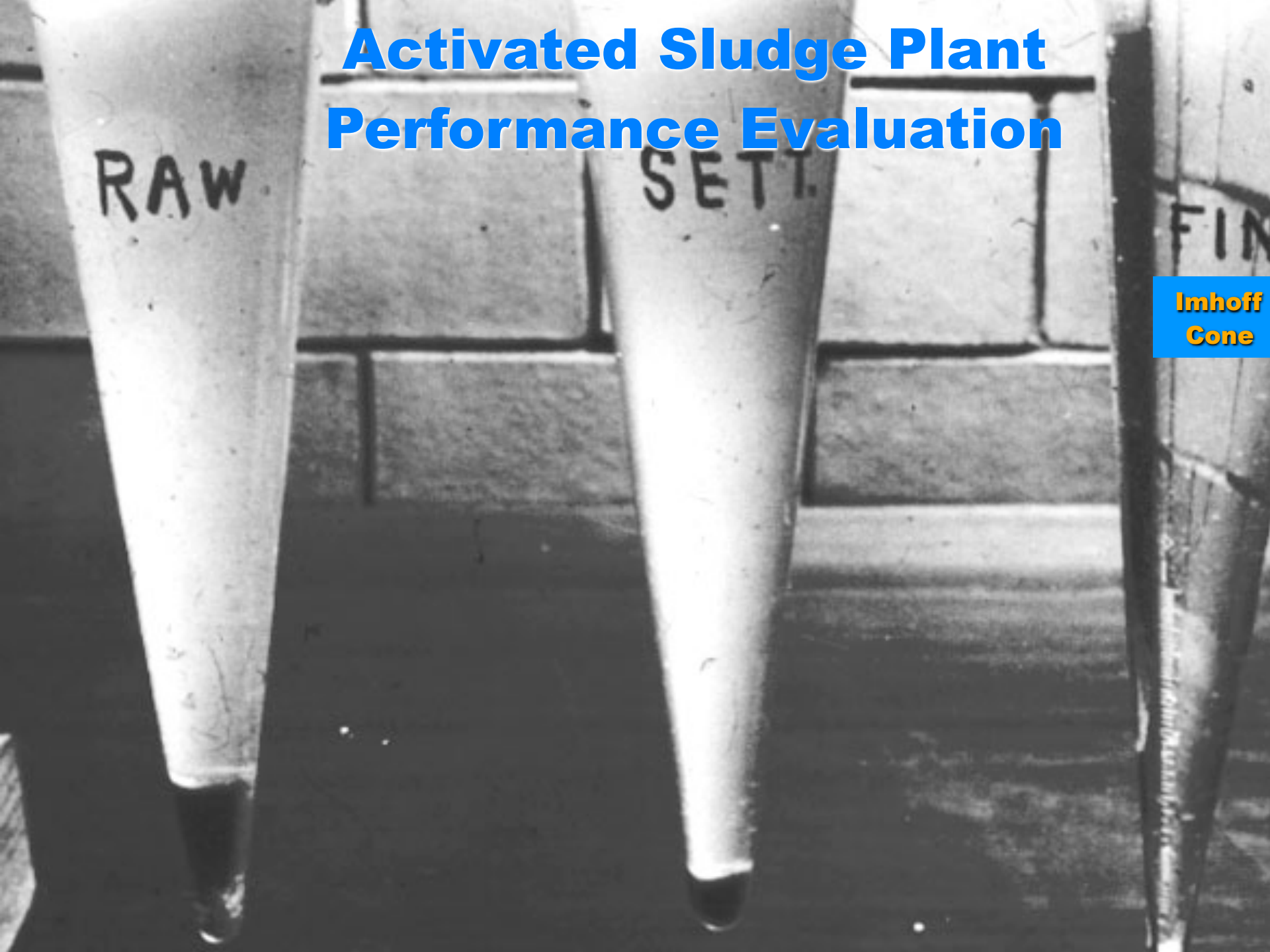

Physical Treatment
Solids Removal

Trickling Filter

Popular with Birds - “BOD flies away”

Aeration Tanks
208

Activated Sludge Plant Performance Evaluation

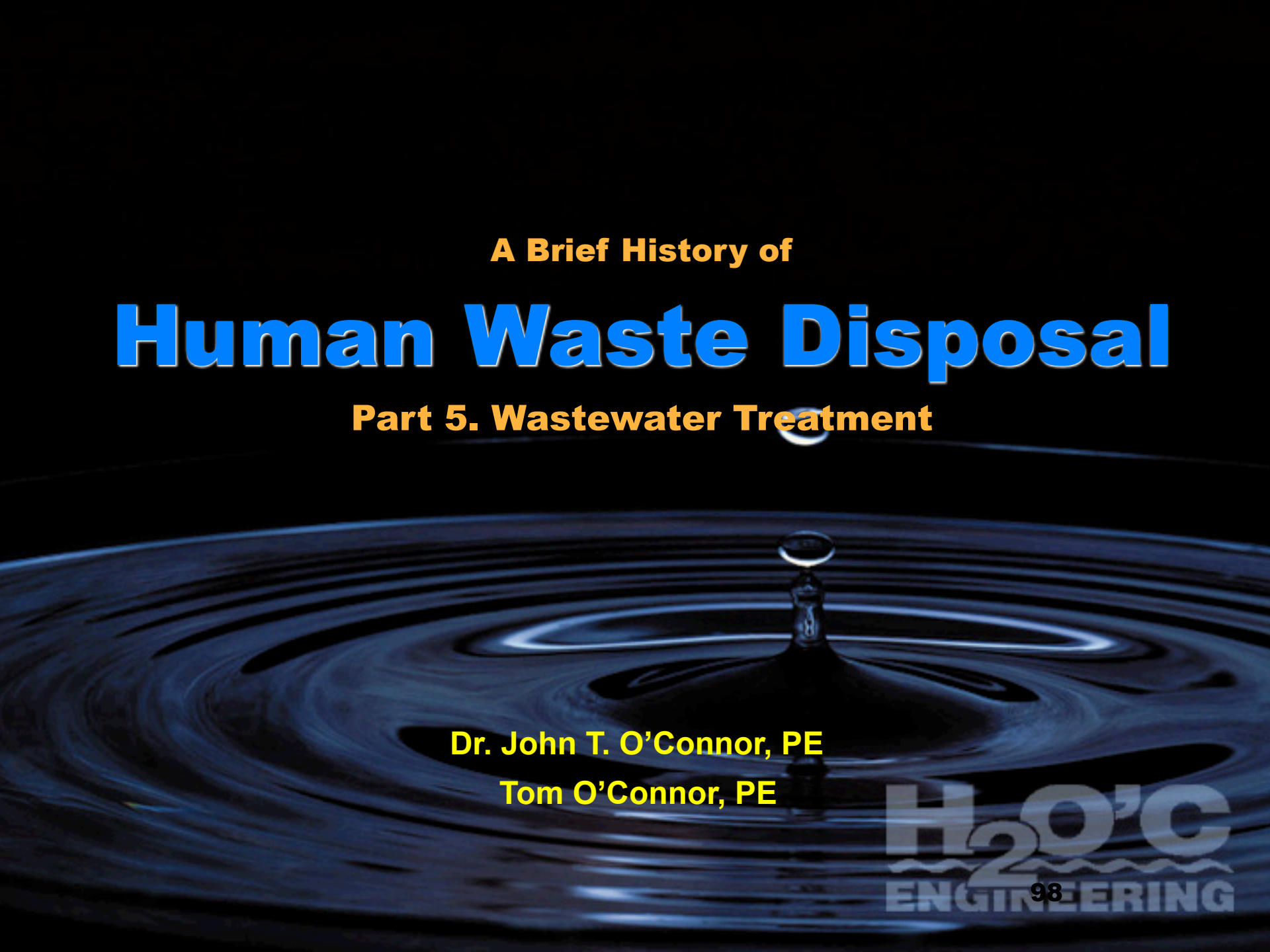


Community Water Supply - Wilder, TN. - 1942

A Brief History of

Human Waste Disposal

Part 5. Wastewater Treatment

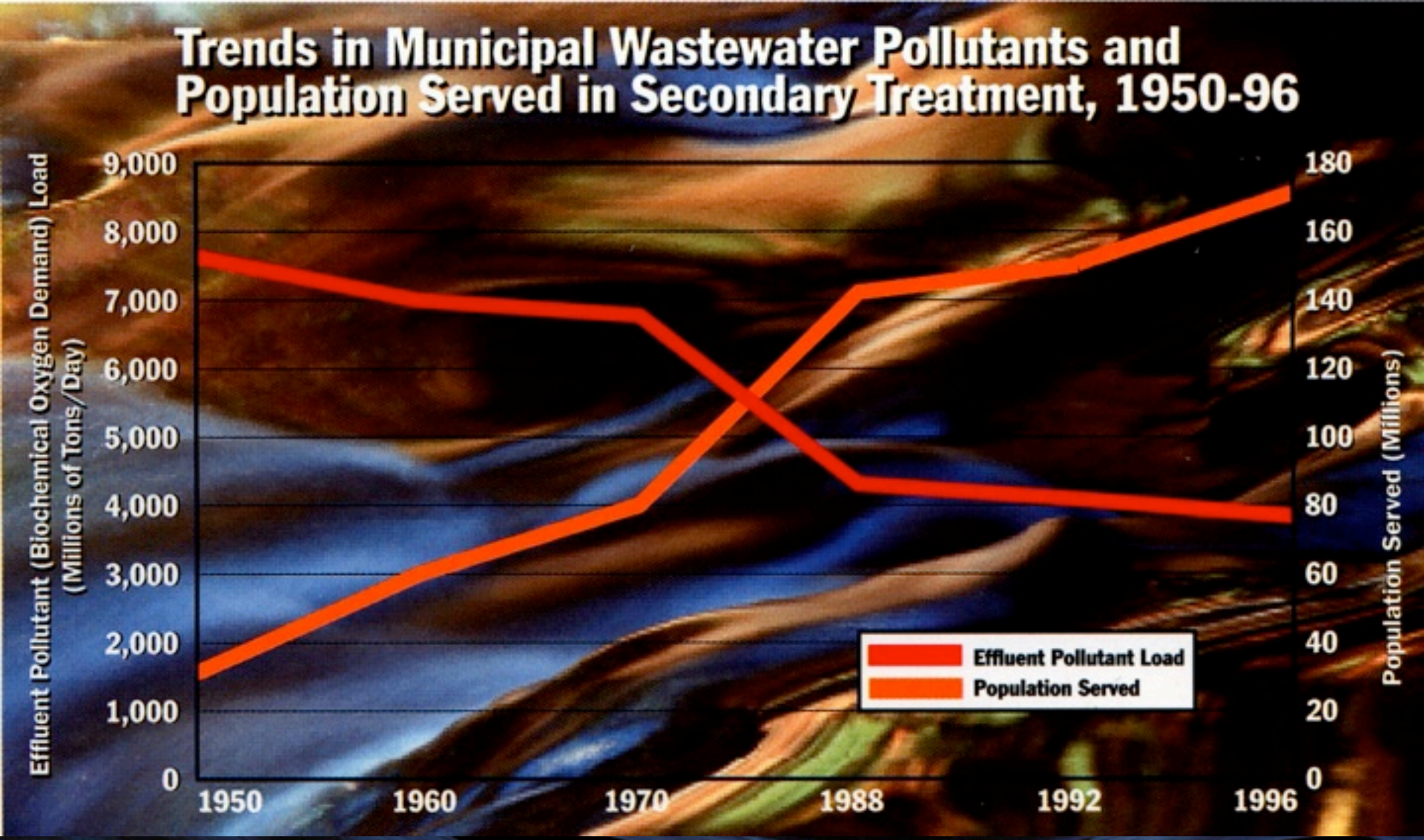


Dr. John T. O'Connor, PE

Tom O'Connor, PE

H2O'C ENGINEERING

Trends in Municipal Wastewater Pollutants and Population Served in Secondary Treatment, 1950-96

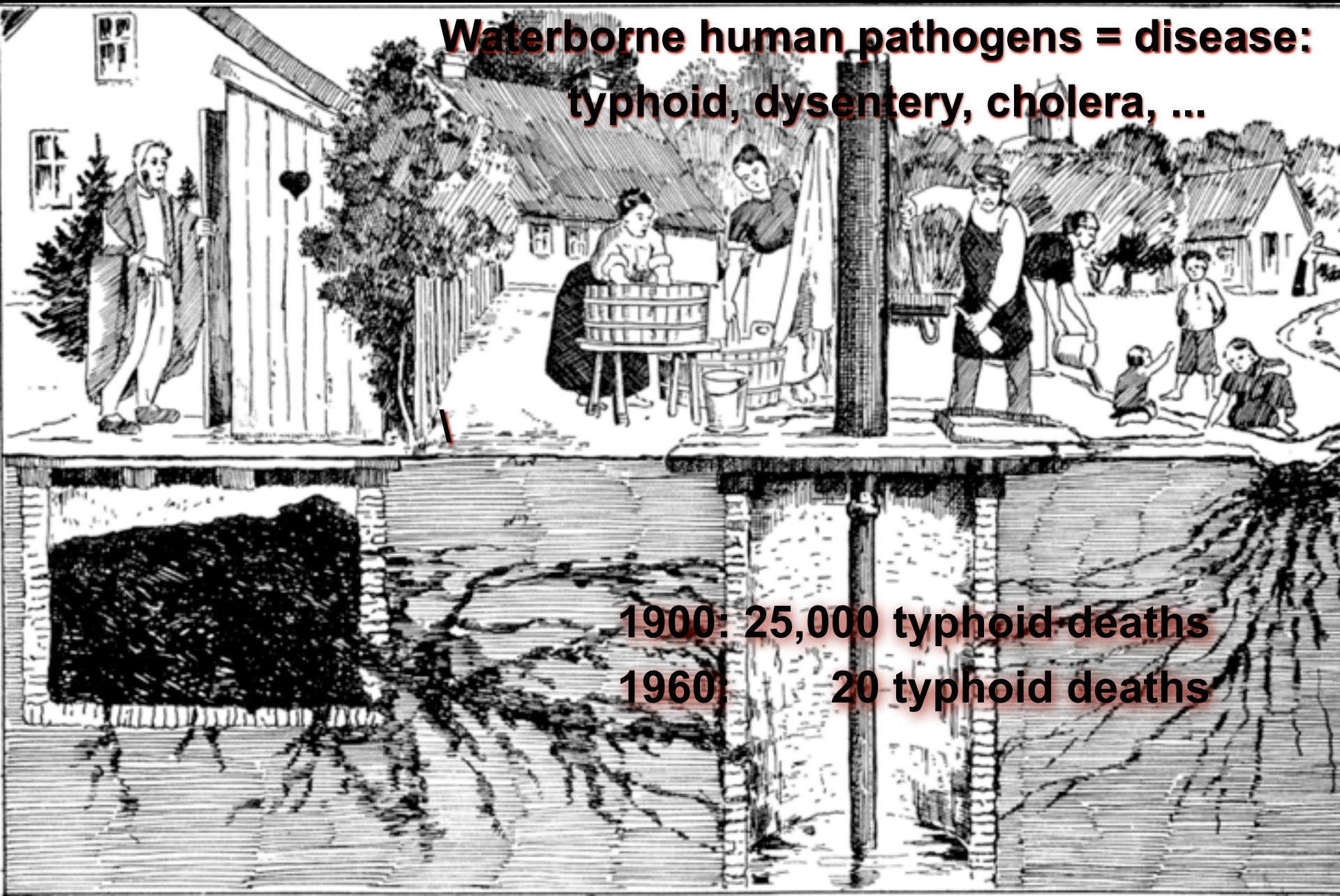


H2O'C ENGINEERING

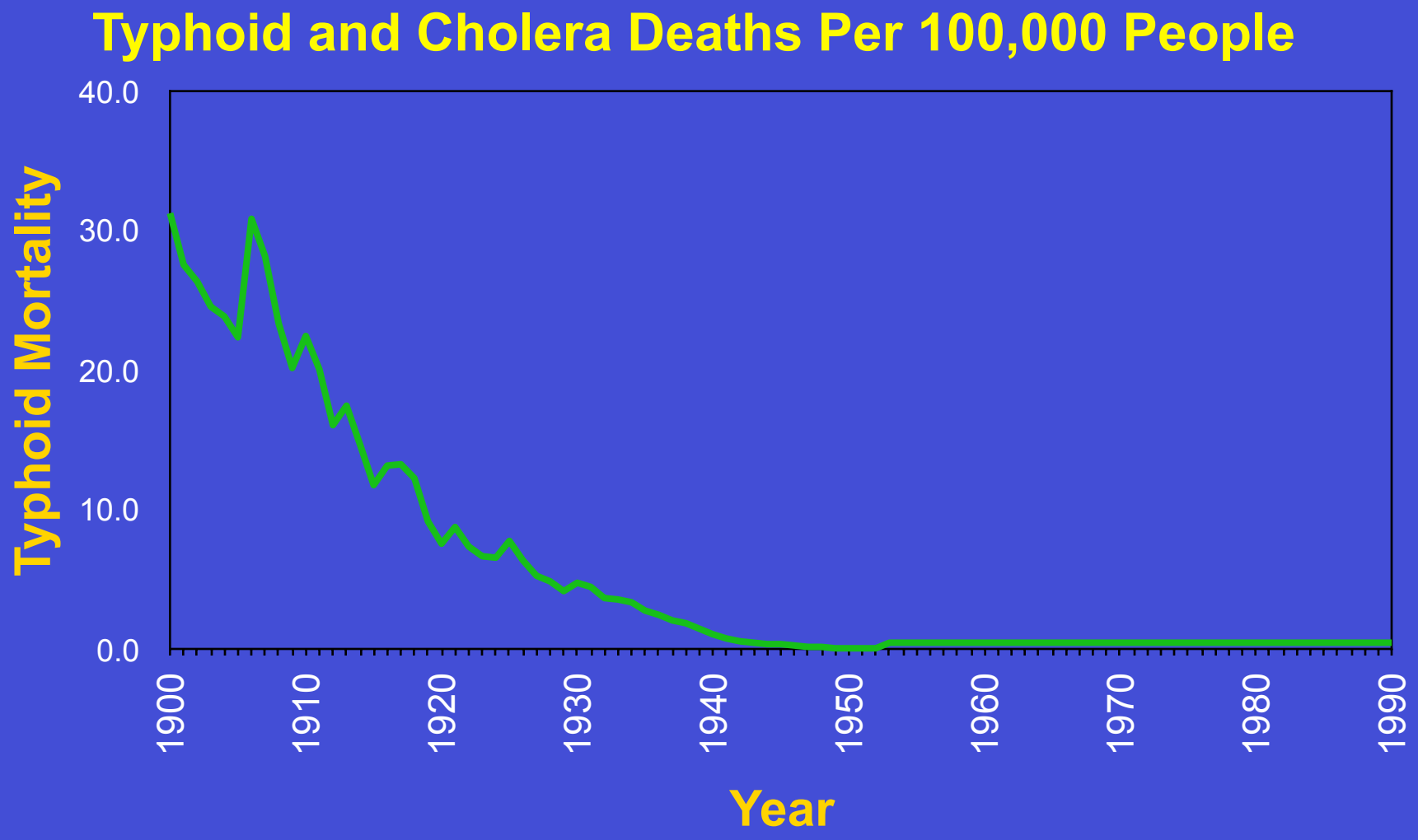
Pollution Control Legislation

1948	Water Pollution Control Act
1956	Fed. Water Pollution Control Act
1961	Amendments to FWPCA
1965	Water Quality Act
1966	Clean Water Restoration Act
1970	USEPA Established
1972	FWPCA Approved
1981	Construction Grants Amendments
1987	Water Quality Act

Why Disinfect Wastewater?



History of Chlorination in the U.S.



Why Disinfect Wastewaters?

2. Environmental Concerns

Cl_2

ClO_2

O_3

UV

O'C ENGINEERING

LA Fish, Crab, Eel, Stingray Kill

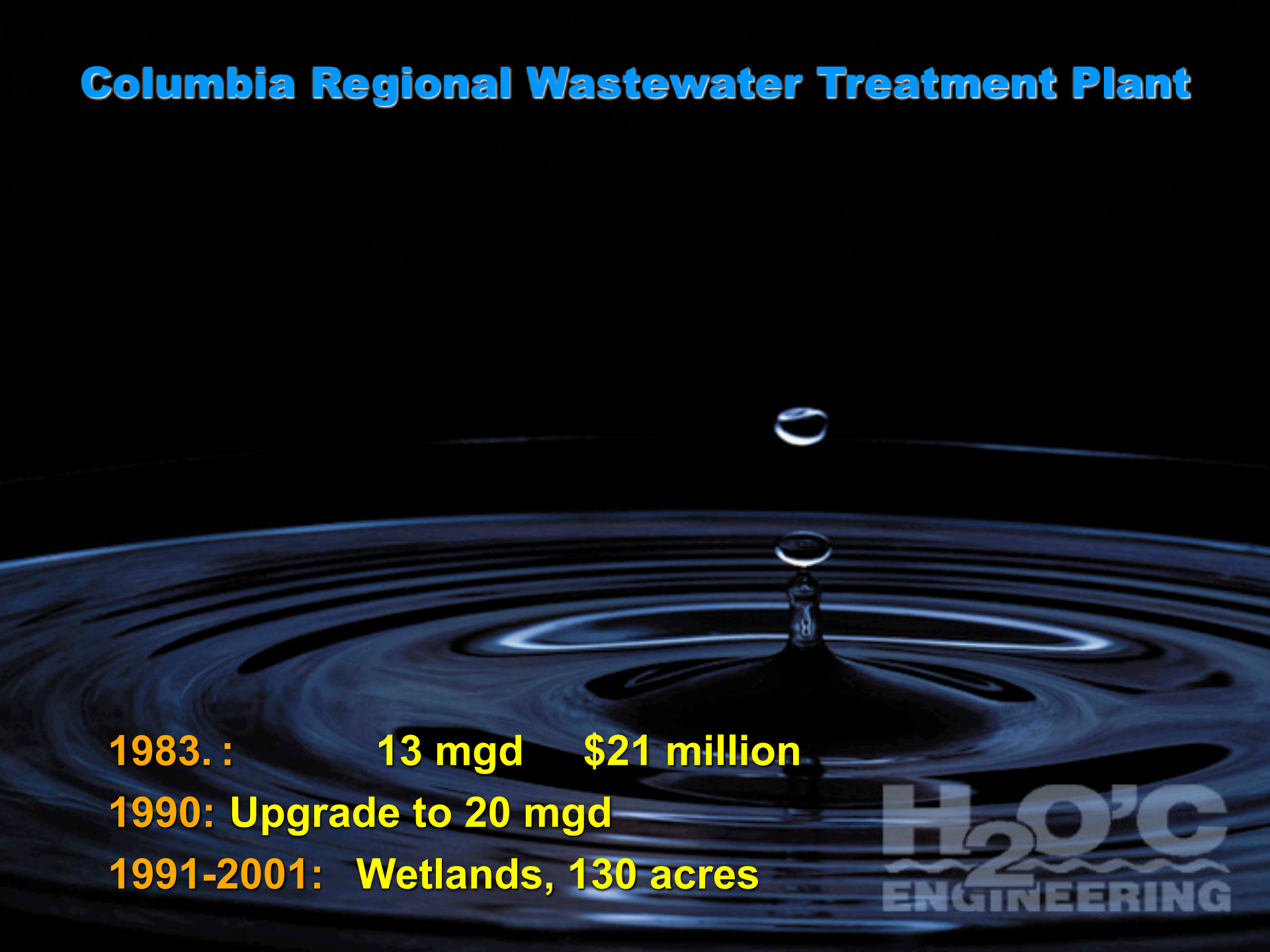
Plaquemines Parish, September, 2010

LA Fish, Crab, Eel, Stingray Kill

Plaquemines Parish, September, 2010

Kill attributed to high temperatures and
oxygen depletion;
farm runoff, not BP

Columbia Regional Wastewater Treatment Plant



1983. : 13 mgd $21 million

1990: Upgrade to 20 mgd

1991-2001: Wetlands, 130 acres

H2O'C ENGINEERING

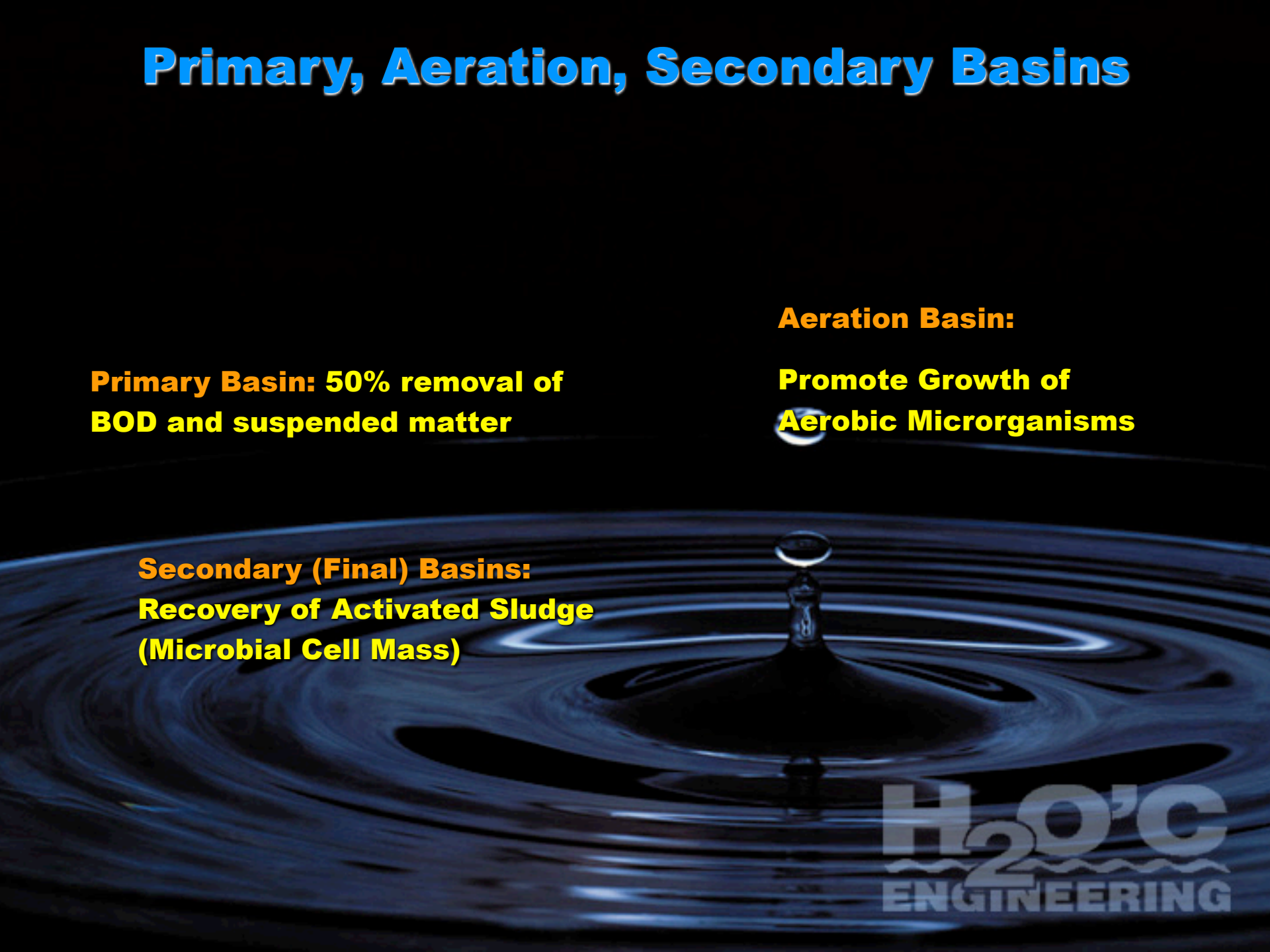
Primary, Aeration, Secondary Basins

Primary Basin: 50% removal of BOD and suspended matter

Aeration Basin:

Promote Growth of Aerobic Microrganisms

Secondary (Final) Basins:
Recovery of Activated Sludge (Microbial Cell Mass)



Sludge Treatment and Disposal

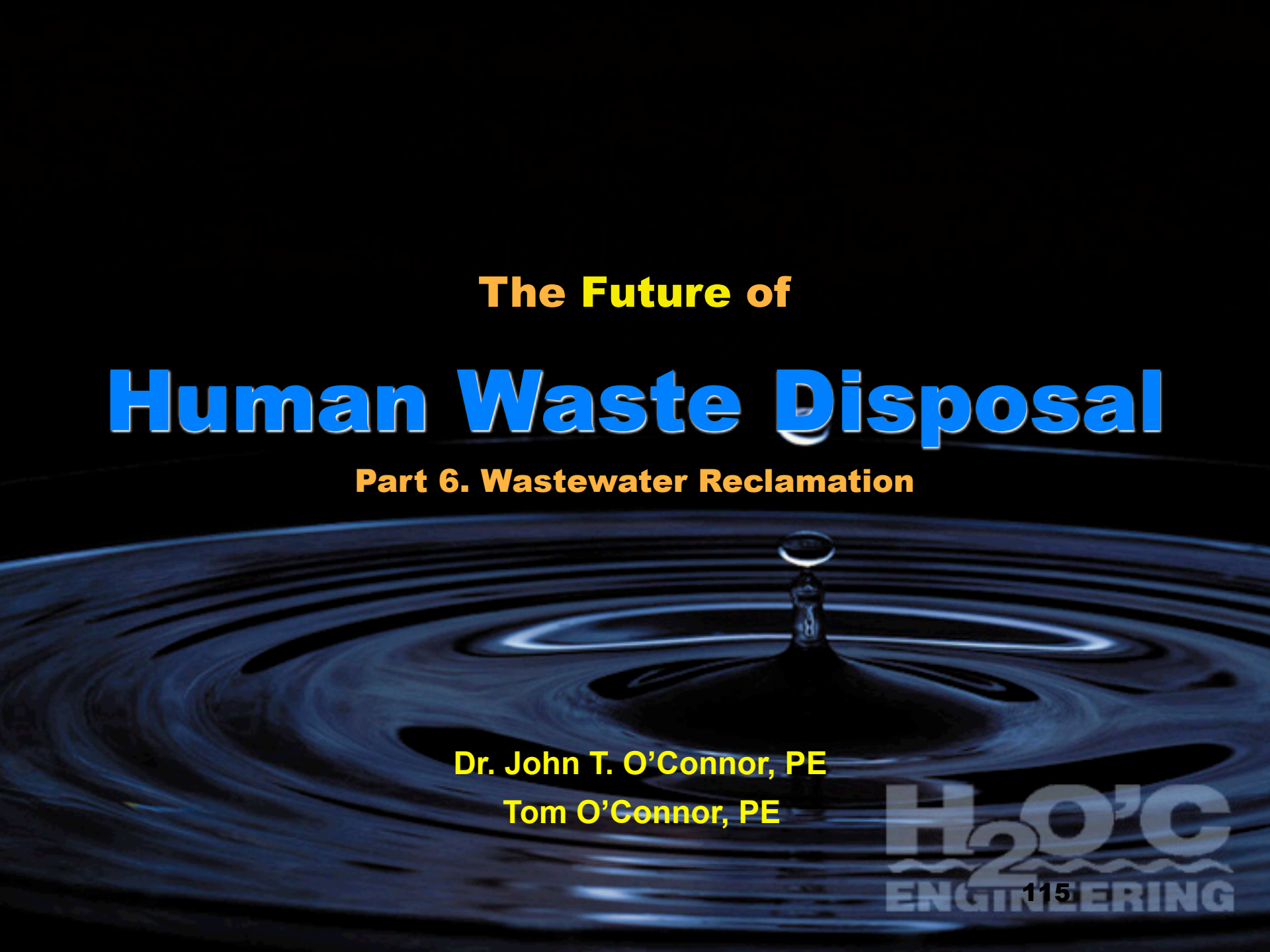
Covered, Heated
Anaerobic Digesters

Digester Gas runs generator
and provides heat

Digested Sludge is applied
to farmland

H2O'C ENGINEERING

Tertiary Treatment



The Future of

Human Waste Disposal

Part 6. Wastewater Reclamation

Dr. John T. O'Connor, PE

Tom O'Connor, PE

H2O'C ENGINEERING

Water Use ⇒ Wastewater

Population Growth x Water Use (130 gpcd, max. month)

Urban Sprawl ⇒ sewer extensons, irrigation of suburbs

Groundwater depletion; drought; consumptive water use

Growing Water Shortages

New Water Sources?

U.S.: 22,000 POTW (98% municipally-owned) ⇒ 35 billion g/d

1 billion g/d (3%) of treated WW ⇒ parks, golf courses, ...

H2O'C ENGINEERING

U.S. Population Growth

	Population, millions	Life Expectancy, years
1933:	125	-
2010:	***310***	***78***
2025:	357	80
2050:	439	83

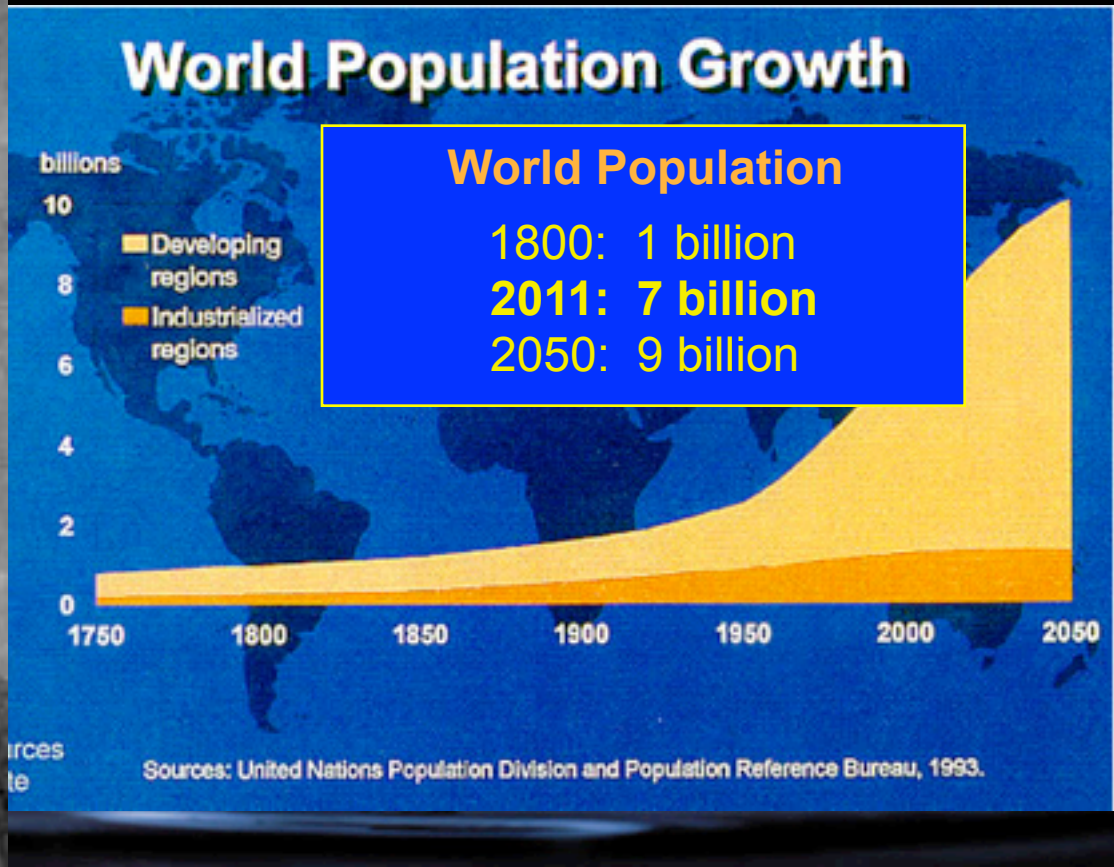
U.S. Population Increase: 3 million/year

New Missouri every 2 years

(Anglican) Reverend Thomas Robert Malthus, 1766-1834

"The power of population is indefinitely greater than the power in the earth to produce subsistence for man".
An Essay on the Principle of Population

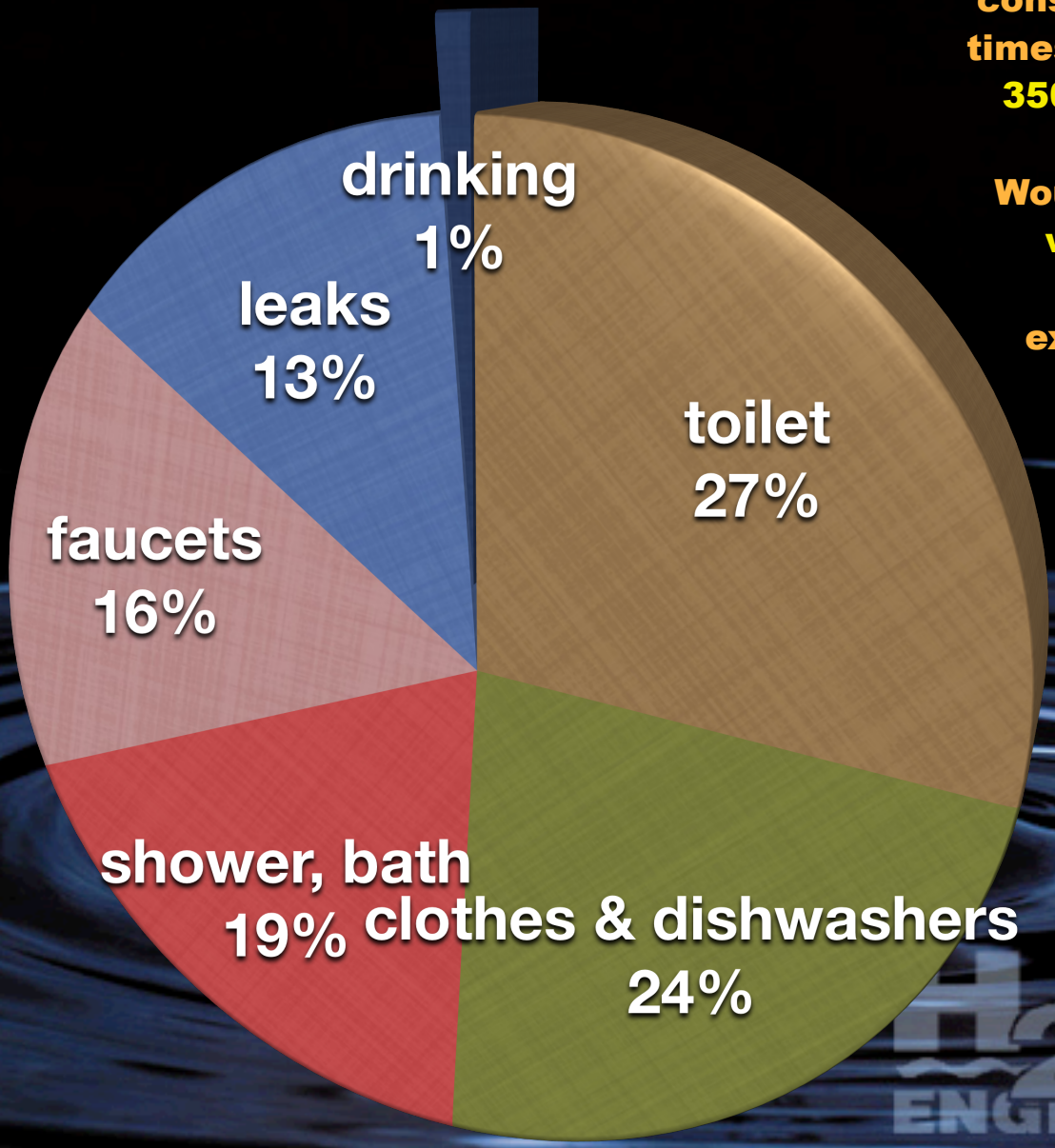
If Malthus is wrong, then will human population growth go on forever?



Suburban homeowners are ‘grass farmers’

60% of water use is outdoors; **only 40% indoors**

% Daily Indoor Water Use



Some households consume two to five times as much as the 350 gpd average?

Would progressive water pricing discourage excessive use?

Managing Wastewater Costs

2. Reduce Hydraulic Loadings

Mandate efficiency of toilets, showers, faucets

Advocate Gray Water use for lawn, gardens, toilets

U.S. Suburban Household Water Use

Average Day: 350 gallons

Toilet flushing: 100 gallons

Gallons per flush: 3.5, 1.6, 1.28, 1.0

Federal Water Efficiency Standards (1992)

Showerheads: 2.5 gallons per minute

Faucets: 2.5 gallons per minute

H2O'C ENGINEERING

Managing Wastewater Costs

2. Water Conservation Programs

Offer Financial incentives to install water-efficient toilets

Pass Municipal ordinances allowing watering only on certain days

Ban ornamental fountains unless they run on re-circulated water

Require homes to have low-flow shower heads and faucet aerators

Recycle Gray Water

"If it's yellow,
let it mellow;
if it's brown,
flush it down."

H2O'C ENGINEERING

When freshwater gets scarce … utilize ‘toilet to tap’, a.k.a.

Wastewater Reclamation & Reuse

California State Department of Health

permits use of reclaimed wastewater for:

- ☑ agricultural irrigation of over *20 food crops**,
- ☑ landscape parks, playgrounds, golf courses,
- ☑ restricted recreational impoundments,
- ☑ groundwater recharge to *domestic water supply areas*

*Apples, Grapes, Asparagus, Lettuce, Avocados, Maize, Barley, Peaches, Beans, Peppers,Broccoli, Pistachios, Cabbage, Plums, Cauliflower, Squash, Celery, Sugar Beets, Citrus, Wheat

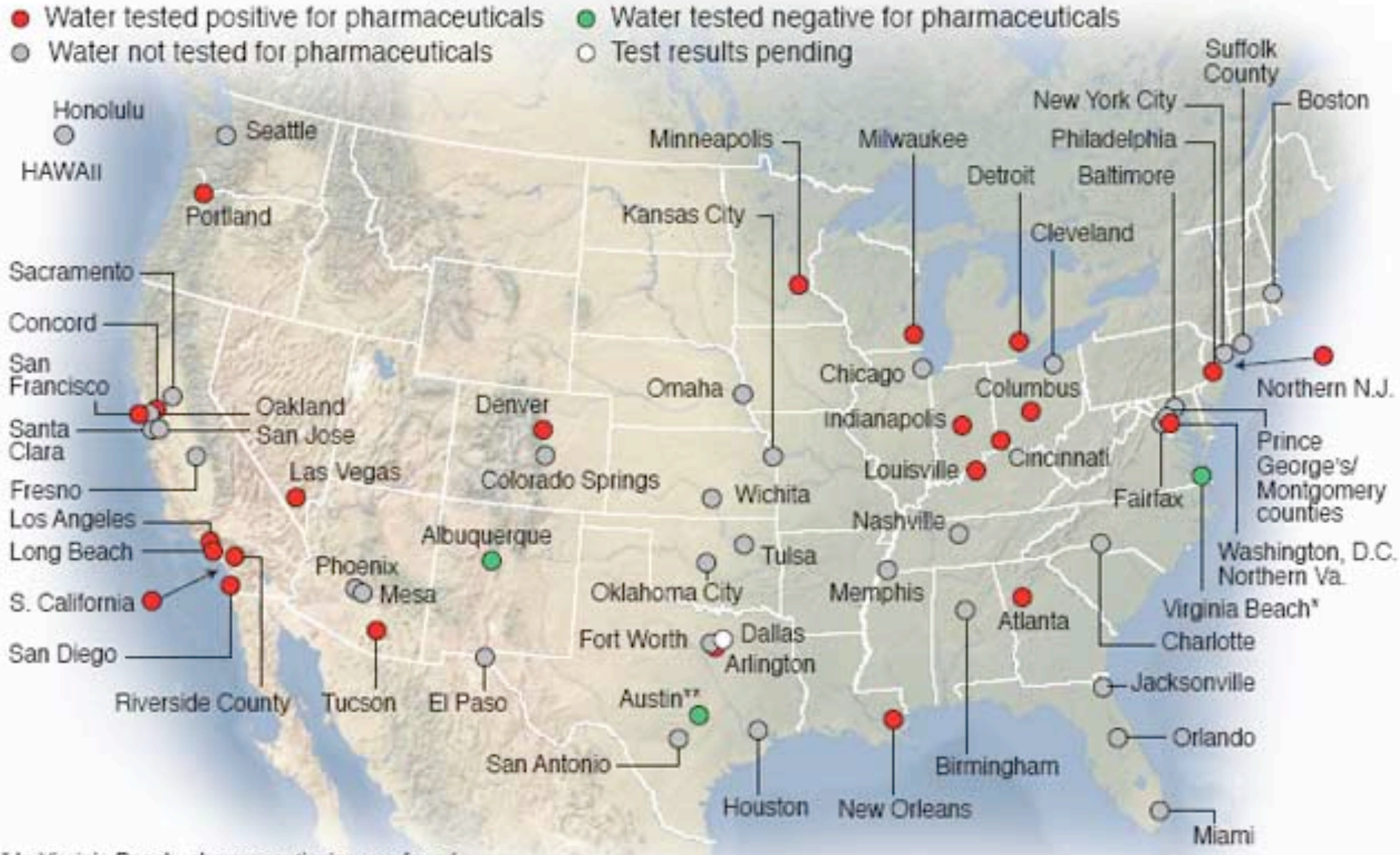
Emerging Health Concerns

- **pharmaceuticals:** N-nitrosodimethylamine (NDMA), 1,4-dioxane, bisphenol A, alkylphenol polyethoxy carboxylates (APECs), dioxin, disinfection by-products, ...
- **cosmetics, hormones, nanomaterials**
- **endocrine disruptors,** a class of compounds that perturb the normal functioning of endocrine systems including those that affect growth, reproduction and behavior.

Partial removal requires capital, energy-intensive processes:

(GAC adsorption; ozonation; micro-, ultra-, nano-filtration; reverse osmosis; membrane bioreactors; advanced oxidation (hydrogen peroxide - UV)

Pharmaceuticals in drinking water



* In Virginia Beach, pharmaceuticals were found in source water but not in treated drinking water.
** Drinking water in Austin, Texas, was tested for only one prescription drug, a synthetic birth control chemical.

NOTE: All places include some surrounding areas except: Albuquerque, N.M.; Arlington, Texas; Fresno, Calif.; Long Beach, Calif.; Los Angeles; Memphis, Tenn.; New Orleans; New York City; and Orlando, Fla.

SOURCES: Drinking water providers' responses to Associated Press questions; AP review of scientific literature.

AP

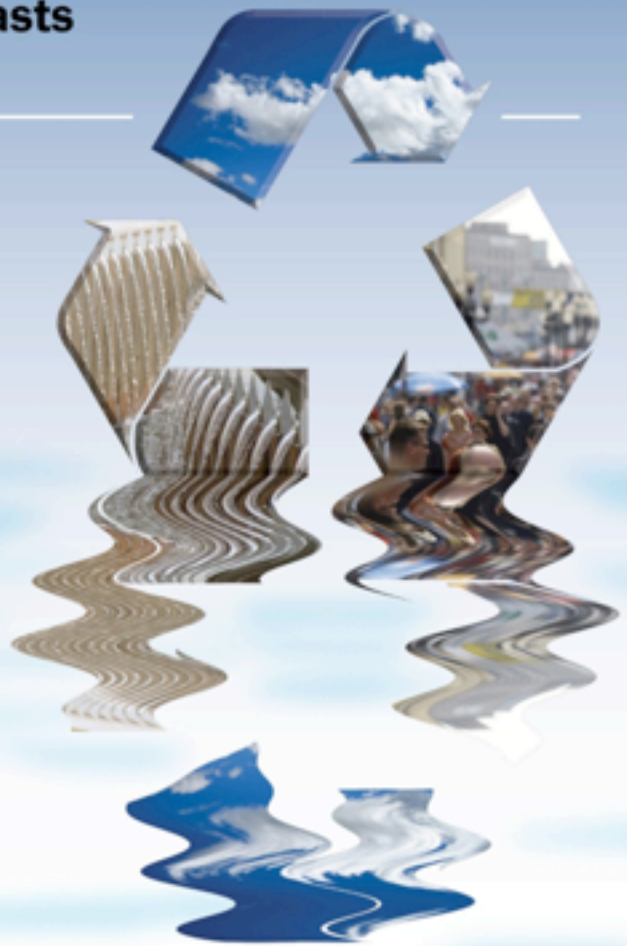
Orange County, CA Water District

'Indirect Potable Water Reuse'

70 mgd - Groundwater Replenishment System

Municipal Water Reuse Markets 2010

Analysis, forecasts and inventory



Global Water Intelligence

A Global Water Intelligence publication

www.globalwaterintel.com

Produced in collaboration with PUB Singapore

PUB

"NEW REVENUE STREAM SPRINGS UP "

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"... water reuse can be an essential part of sustainable cities".

H2O'C ENGINEERING

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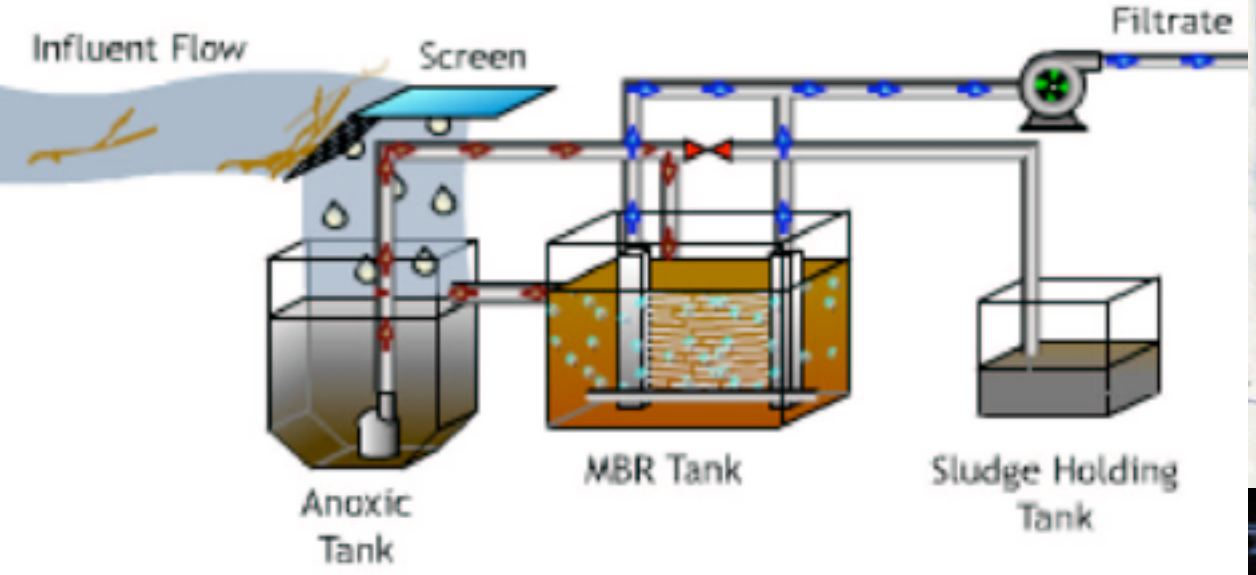
KCMO Symbol

Tapping into Sewers

'Sewer Mining' for 'Brown Gold'

Membrane Bioreactors



Requires Chemical Control of Membrane Fouling

Membrane Module

Sewer Mining?

Padlock your manholes?

Membrane Bioreactors (MBR)

membranes immersed into highly concentrated mixed liquor suspended solids

Hydraulic Retention Time: 4-8 hours; 25% conventional footprint

Solids Retention Time: 10- 365 days; 20% conventional sludge yield

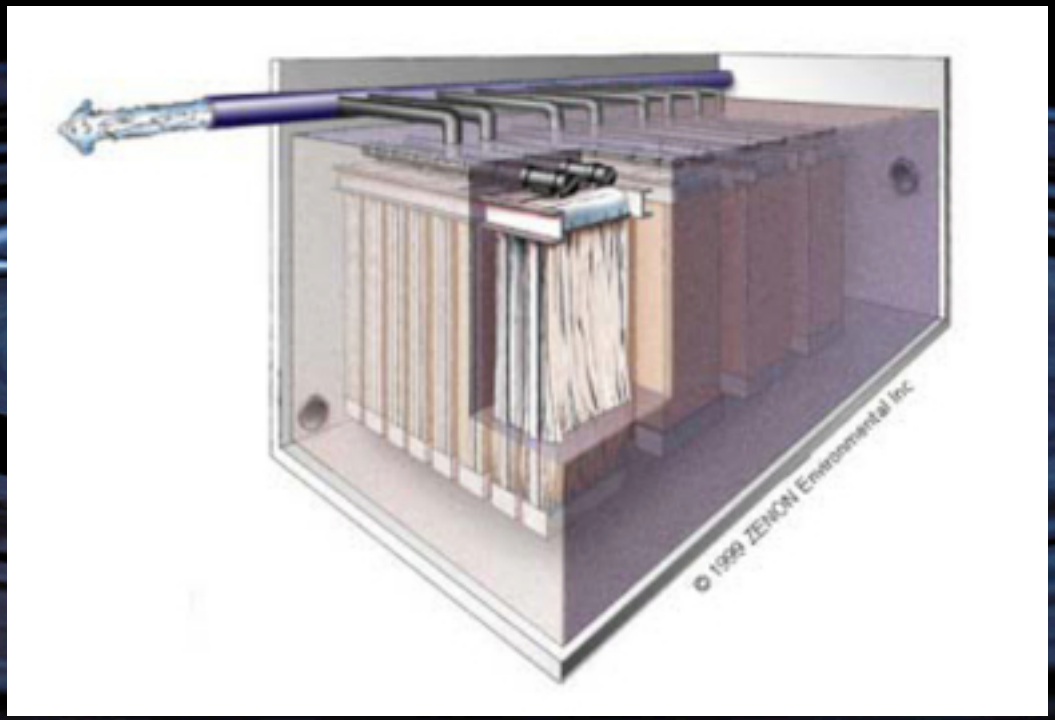
MLSS: 10,000 - 15,000 mg/l

Modular: small scale

Effective organism removals

Removal of nutrients

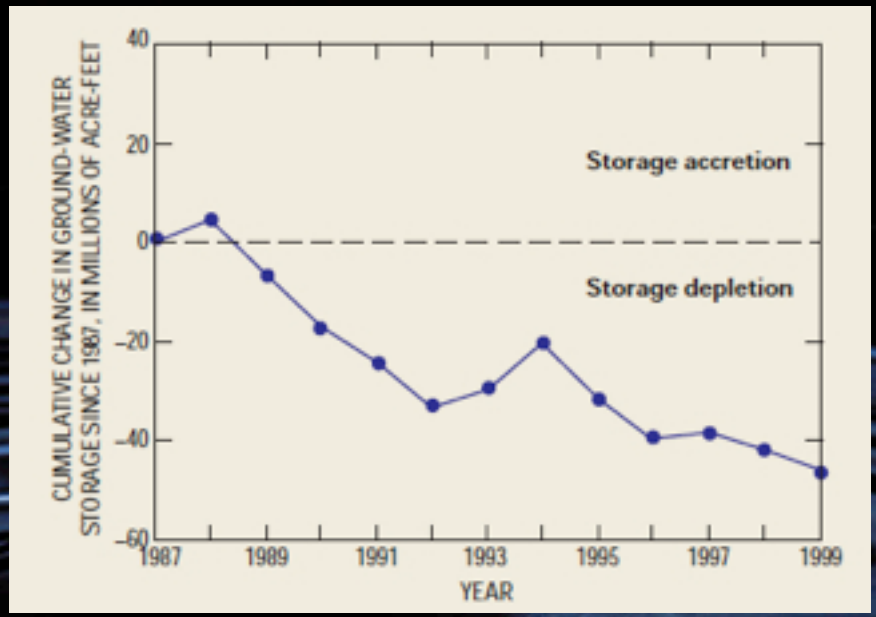
Reuse of product water

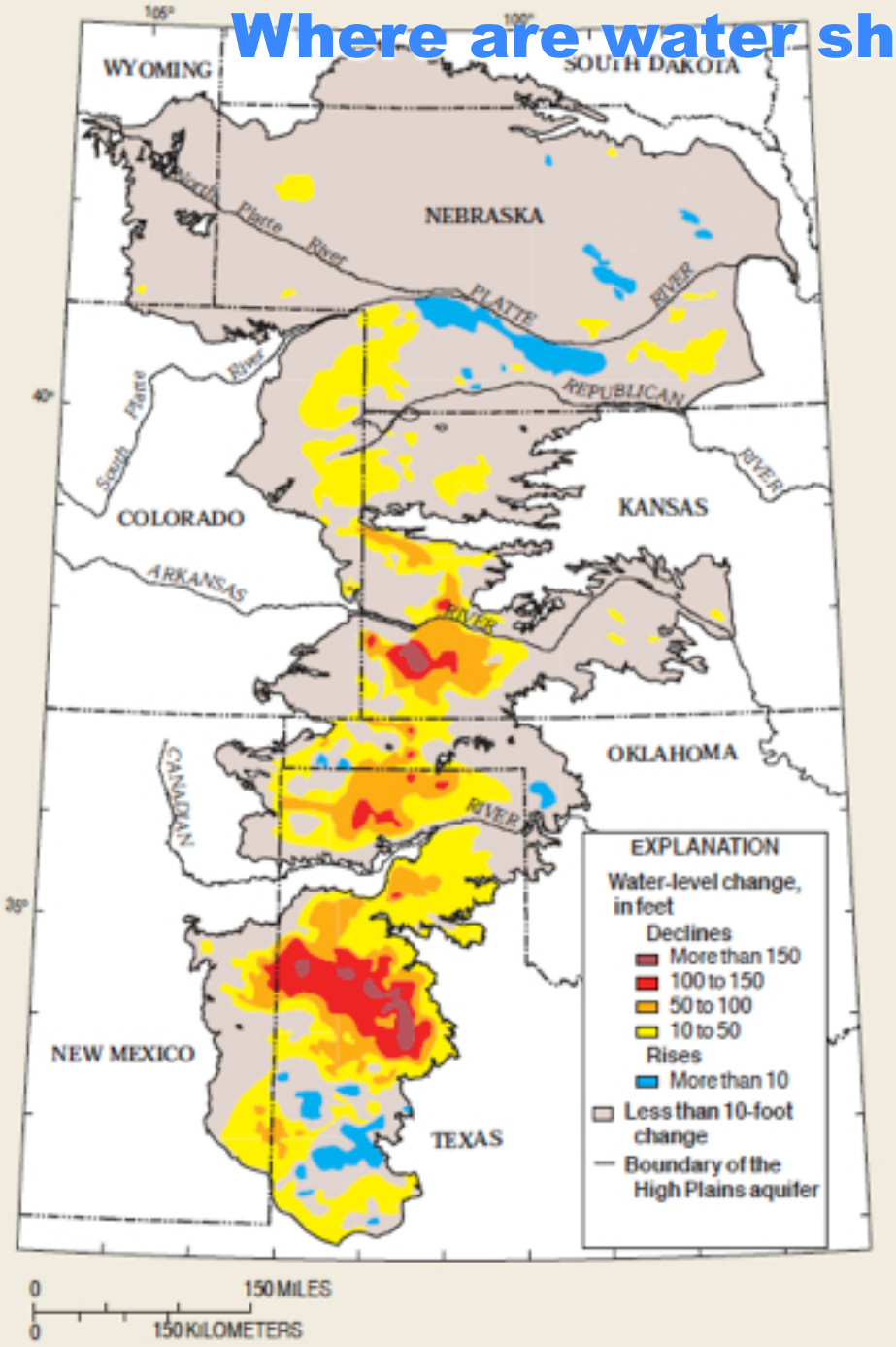


Where are water shortages developing?

High Plains Aquifer:

- water-level declines > 150 feet
- 220 million acre feet removed





Where is Reclamation Occurring?

CA, FL, TX, AZ, NM, NE, CO, GA, WA, VA, NY, MA

Orange County Water District
Central/West Basin
Metropolitan Water District
San Jose
Los Angeles Co Sanit District
San Diego County
Irvine Ranch
Dublin San Ramon
East Bay Municipal Utility District
Orlando
Scottsdale
Phoenix

San Antonio
El Paso
Tarrant Regional
St. Petersburg
Pinellas County
King County (WA)
Austin
Santa Rosa
UOSA (VA)
Southwestern Nevada Water Authority/
Las Vegas Valley Water District

Foxboro, MA

H2O'C ENGINEERING

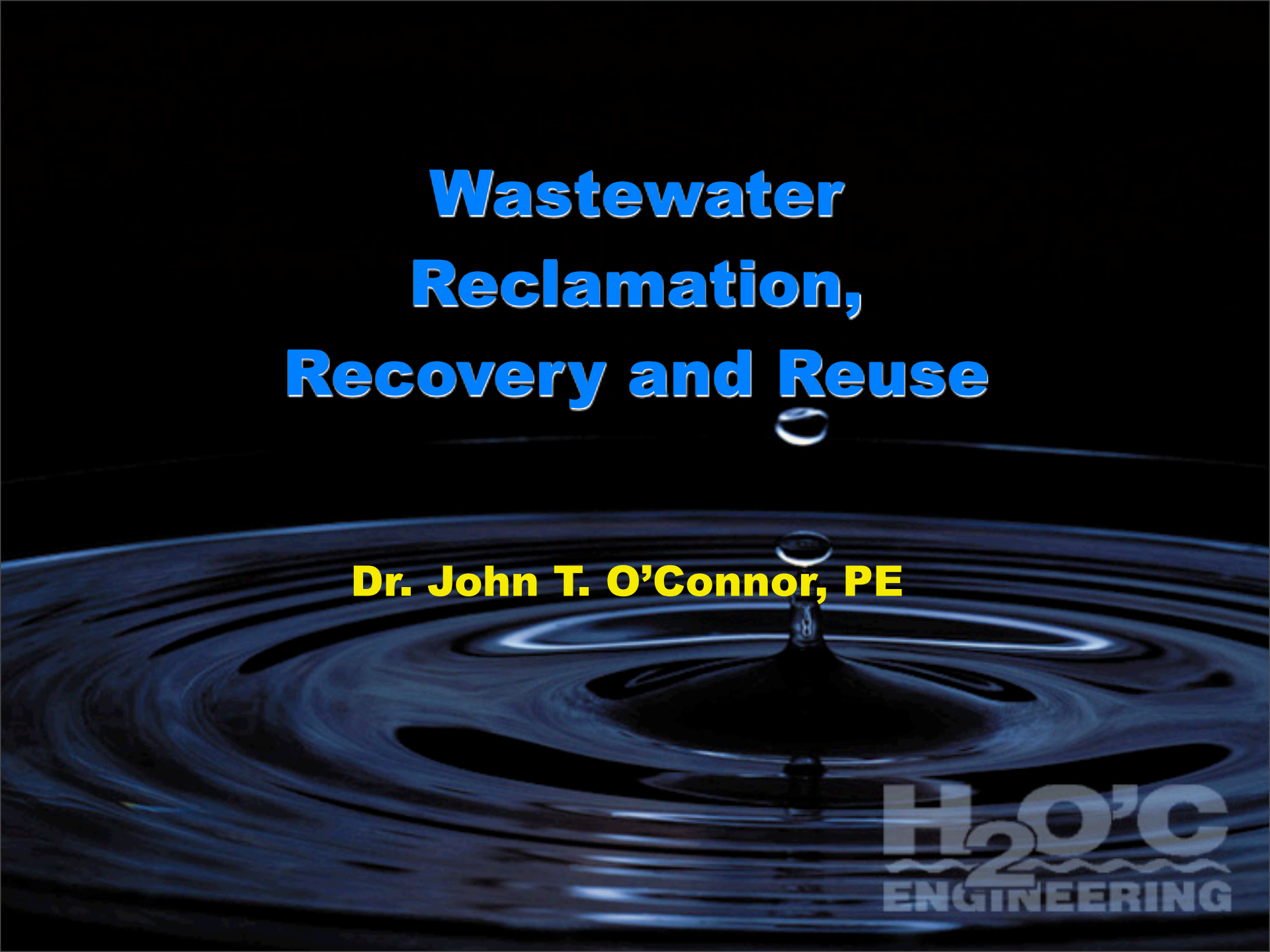
0.25 mgd used for toilet flushing

The Future of Waste Management ?

- energy, chemicals, and materials costs ⇒ *rate increases*
- reduction of federal subsidies, grants ⇒ *rate increases*
- consolidation of W & WW systems ⇒ *staff reductions*
- reclamation of wastewater ⇒ *reuse, groundwater recharge*
- conservation ordinances ⇒ *water use reductions*

Wastewater Reclamation, Recovery and Reuse

Dr. John T. O'Connor, PE



Toilet to Tap? Finding Where the Water Is!

There are no more orange groves in Orange County, California.

Instead, population grows and water is in increasingly short supply. However, there is an ever-increasing flow of *wastewater* (a.k.a., *sewage*).

Now, a $481m *groundwater replenishment system* employing microfiltration, reverse osmosis and UV-peroxide oxidation is purportedly making wastewater *'as pure as distilled water'*...

H2O'C ENGINEERING

Orange County, CA Water District

'Indirect Potable Water Reuse'

70 mgd - Groundwater Replenishment System

When freshwater gets scarce … utilize 'toilet to tap', a.k.a.

Wastewater Reclamation & Reuse

California State Department of Health

permits use of reclaimed wastewater for:

- ☑ agricultural irrigation of over *20 food crops**,
- ☑ landscape parks, playgrounds and golf courses,
- ☑ restricted recreational impoundments,
- ☑ groundwater recharge to *domestic water supply areas*

*Apples, Grapes, Asparagus, Lettuce, Avocados, Maize, Barley, Peaches, Beans, Peppers,Broccoli, Pistachios, Cabbage, Plums, Cauliflower, Squash, Celery, Sugar Beets, Citrus, Wheat

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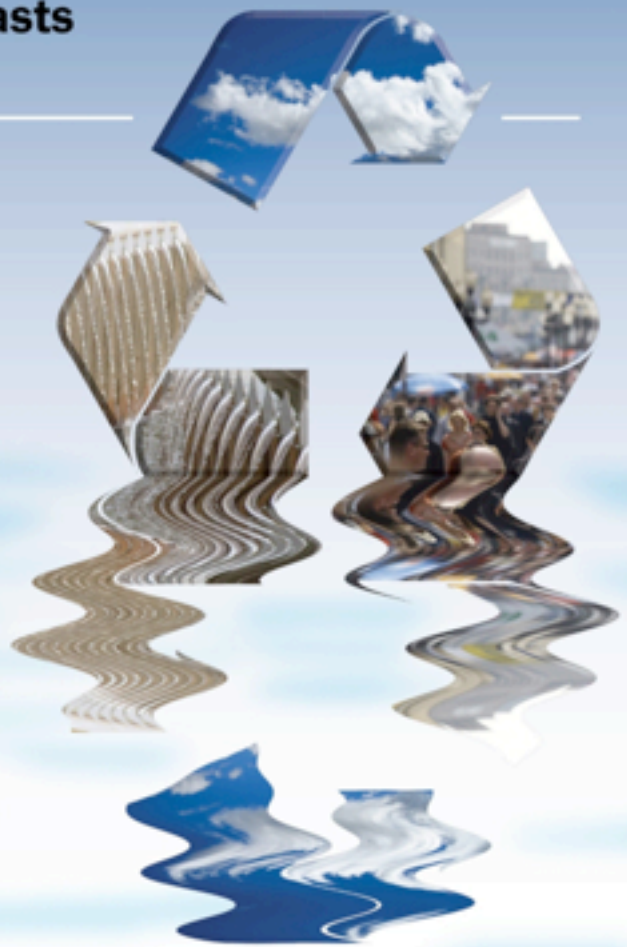

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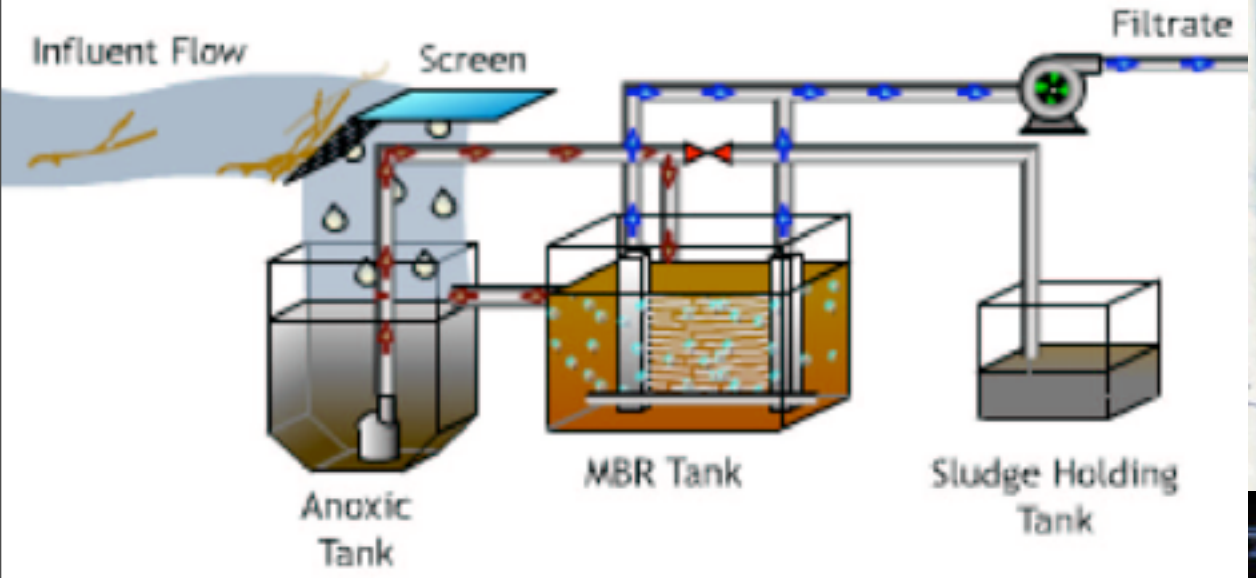

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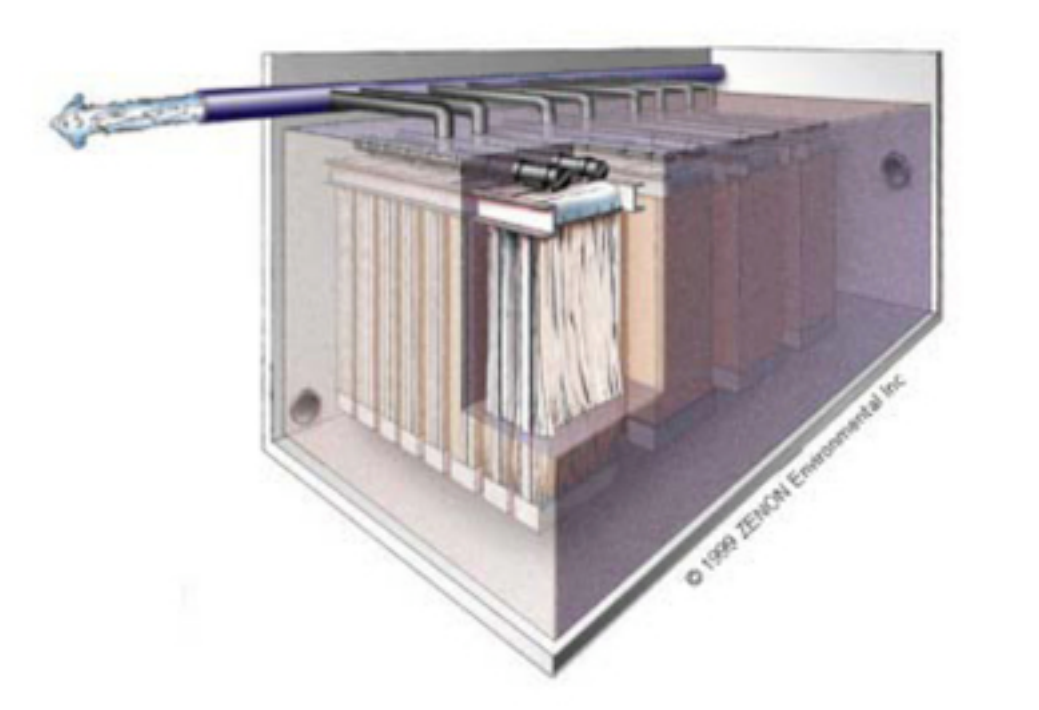


Operational Issues

Membrane Bioreactors (MBR)

Fine Screening (1 mm) required; disposal of untreated waste

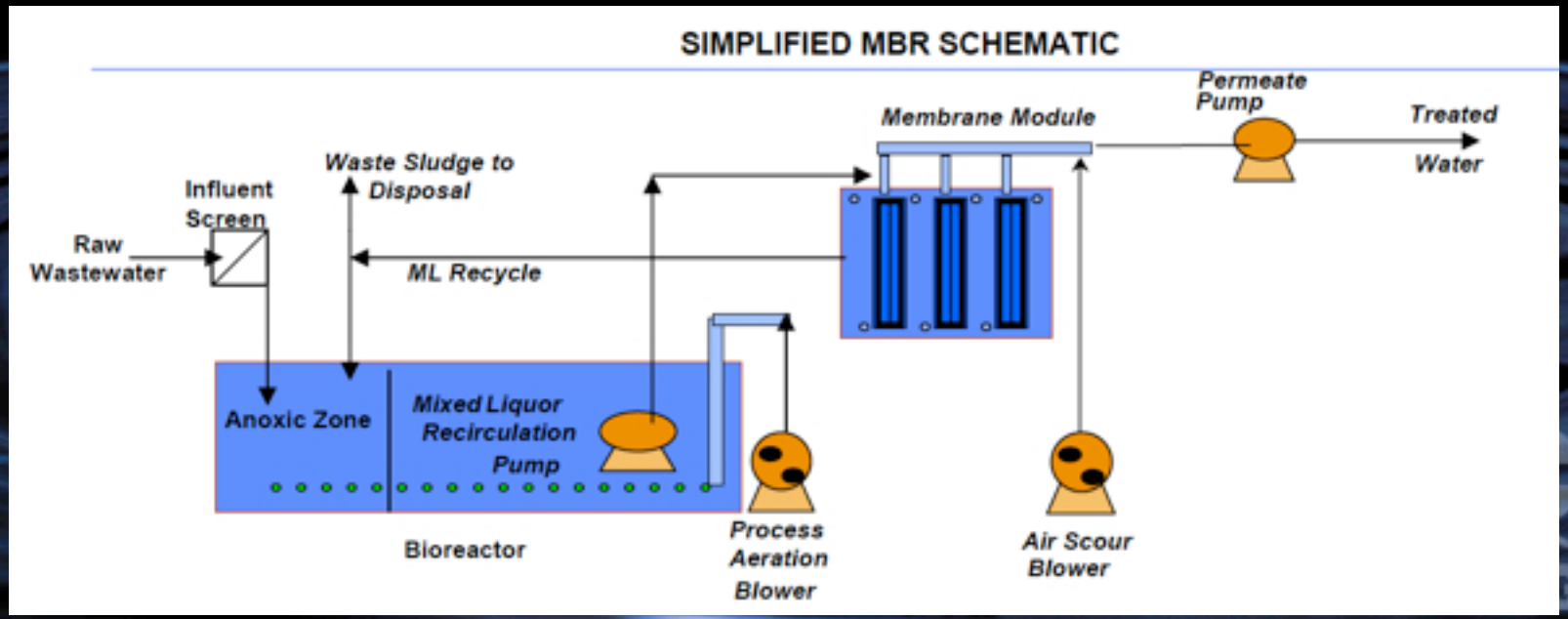
Fouling results in low membrane flux rates; large membrane surfaces

Air Scour, MLSS recirculation: high energy consumption

Large Equalization Tank Volume: to offset low peak flow tolerance

Low Oxygen Transfer Efficiency due to high MLSS

Membrane Replacement Frequency and Costs



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El Paso
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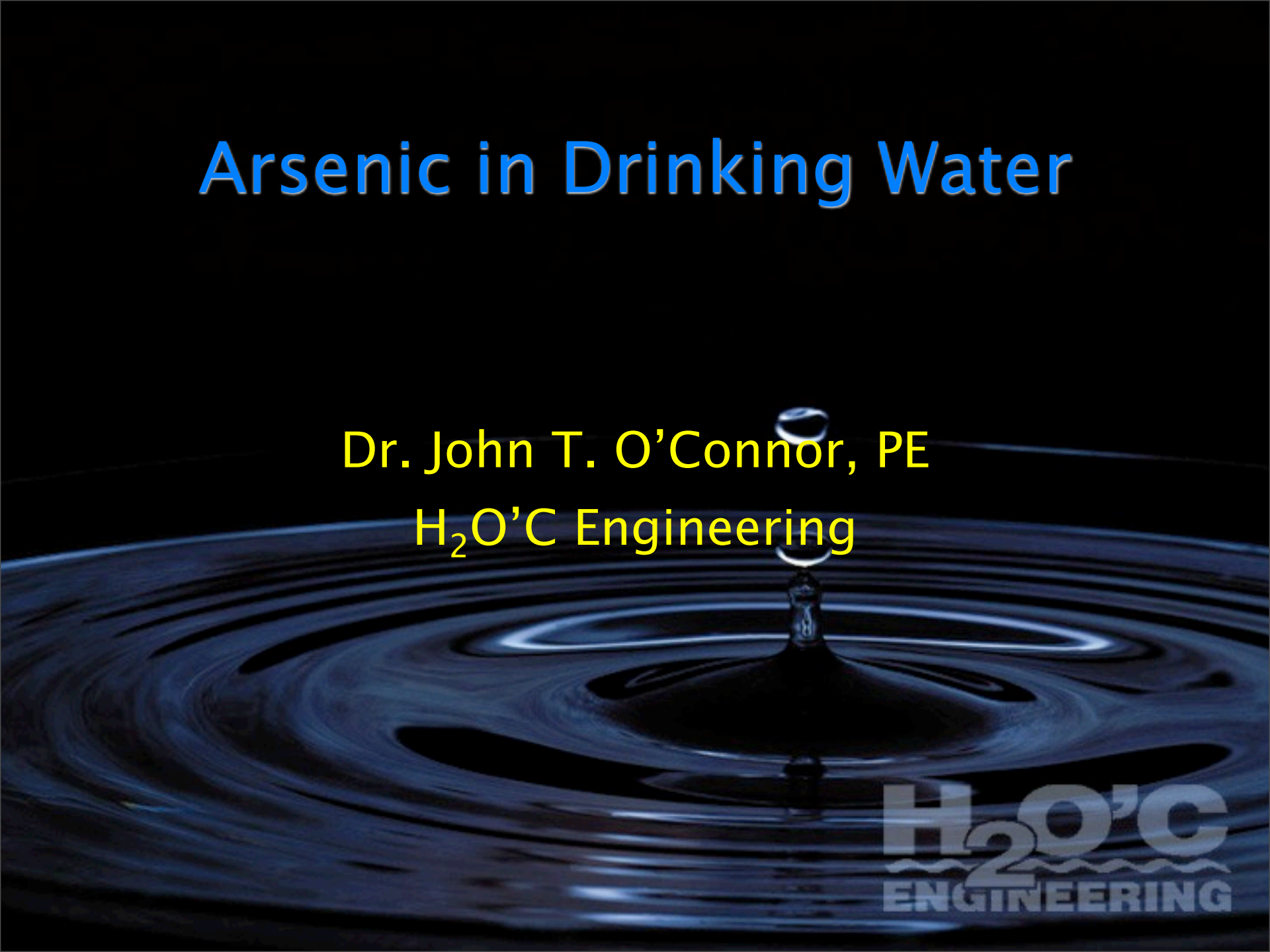
0.25 mgd used for toilet flushing

H2O'C ENGINEERING

Arsenic in Drinking Water

Dr. John T. O'Connor, PE
H_2O'C Engineering



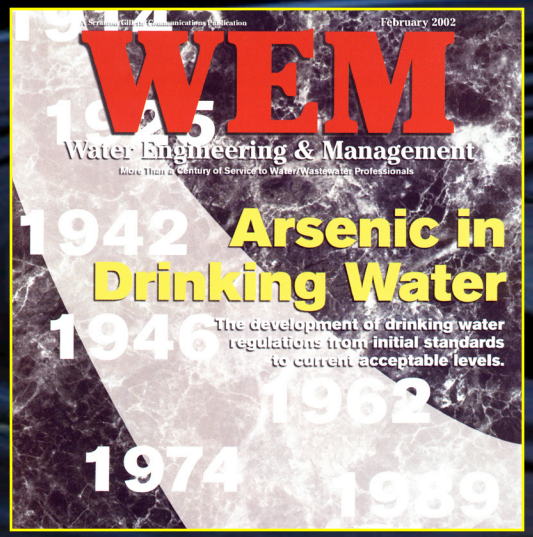
Arsenic in Drinking Water

Part 1. Development of Drinking Water Regulations

Part 2. Human Exposure and Health Effects

Part 3. Occurrence of Arsenic in U.S. Waters

Part 4. Arsenic Removal Methods



***Water Engineering and Management*,**

Volume 149, Numbers 2, 3, 5, 6

February, March, May, June 2002

H2O'C ENGINEERING

Arsenic Species

Arsenous Acid, H_3AsO_3 → $3H^+ + AsO_3^-$

Trivalent Arsenic, As (III) - arsenite ion

Arsenic Acid, H_3AsO_4 → $3H^+ + AsO_4^-$

Pentavalent Arsenic, As (V) - arsenate

H2O'C ENGINEERING

In the most severe case of Arsenic poisoning on record, tens of thousands of people in Bangladesh, India, have reported cancer and lesions all over their bodies, mainly on the hands and feet.

Photos courtesy of Richard Wilson and Harvard University (http://phys4.harvard.edu/~wilson/arsenic_project_pictures2.html)

Arsenic in Drinking Water

Part 2: Human Exposure and Health Effects

Arsenicosis

Arsenic Health Effects

Organ System	Problems (after Dhaka [Bangladesh] Medical College, 1998)
Skin	Symmetric hyperkeratosis of palms and soles, melanosis or depigmentation, Bowen's disease, basal cell carcinoma and squamous cell carcinoma.
Liver	Enlargement, jaundice, cirrhosis, non-cirrhotic portal hypertension
Nervous System	Peripheral neuropathy, hearing loss
Cardiovascular System	Acrocyanosis and Raynaud's Phenomenon
Hemopoietic System	Megalobastosis
Respiratory System	Lung cancer
Endocrine System	Diabetes mellitus and goiter

Linkage of Arsenic to Cancer

2001:

The Johns Hopkins University researchers report the exposure of cell lines to low levels of arsenic trioxide results in a decrease in the activity of the enzyme, telomerase. This enzyme maintains the length of chromosomal ends (telomeres).

The progressive decrease in the length of the telomeres after each healthy cell division could lead to the formation of cancerous cells.

Lung and Bladder Cancer Risk

Table 1: Theoretical Maximum Likelihood Estimates of Excess Lifetime Risk of Lung Cancer and Bladder Cancer for U.S. Populations Exposed at Various Concentrations of Arsenic in Drinking Water (Incidence per 10,000 people)

	Bladder Cancer		Lung Cancer	
Arsenic, µg/L	Females	Males	Females	Males
3	4	7	5	4
5	6	11	9	7
10	12	23	18	14
20	24	45	36	27

CCA-Treated Lumber

By 2004, USEPA will not allow chromated copper arsenate (CCA) products for specified residential (consumer) uses.

Arsenic MCL

1942: USPHS - 50 µg/l arsenic - cardiovascular damage

1975: USEPA begins reevaluating 50 µg/l MCL

1989: USEPA misses deadline for setting MCL

1996: Safe Drinking Water Act Amendments require USEPA to promulgate a revised MCL by January 1, 2001;

- missed deadline extended to June 22, 2001

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Arsenic MCL

1999: NRC - 50 µg/l needs lowering "as quickly as possible"

2000 (June): USEPA proposes a revised MCL of 5 µg/l; requests comments on 3, 10 and 20 µg/l

2000 (Dec): Clinton Administration approves 10 µg/l MCL

2001 (Mar): USEPA Admin. Christine Whitman withdraws MCL

H2O'C ENGINEERING

USEPA Proposes 5 µg/l MCL

2000:

USEPA considers 3 to 20 *µ*g/l and proposes 5 *µ*g/l MCL for arsenic

Mining, wood preserving and *drinking water industry groups* voice strong opposition on economic grounds

Western states strongly object, citing compliance costs for small communities

USEPA MCL Set at 10 µg/l

2001 (January)

Clinton administration approves recommended 10 *µ*g/l arsenic MCL beginning March, 2001;

- **same standard used by European Union**

WHO (International Drinking Water Standards, 1971) provisionally recommended 10 *µ*g/l "because of the lack of suitable testing methods"

Based on health concerns alone, WHO arsenic standard "would be lower still"

H2O'C ENGINEERING

New Administration Opposes MCL

2001 (February)

Congressional opposition voices outrage over hastily drawn, "midnight" regulation.

Mining and wood-preserving industries initiate lawsuit attacking USEPA's "science"

Albuquerque, NM; El Paso, TX plus smaller utilities join industries suit.

Senator Pete Domenici (R-NM) introduces bill to void the arsenic standard

USEPA MCL Withdrawn

2001 (March)

New USEPA Administrator withdraws 10 *µ*g/l arsenic standard citing concern over costs

President Bush calls for decision based on "sound science"

Christine Todd Whitman initiates 'independent review' by a new, *select* NRC panel.

Arsenic health risk assessment due in August, 2002.

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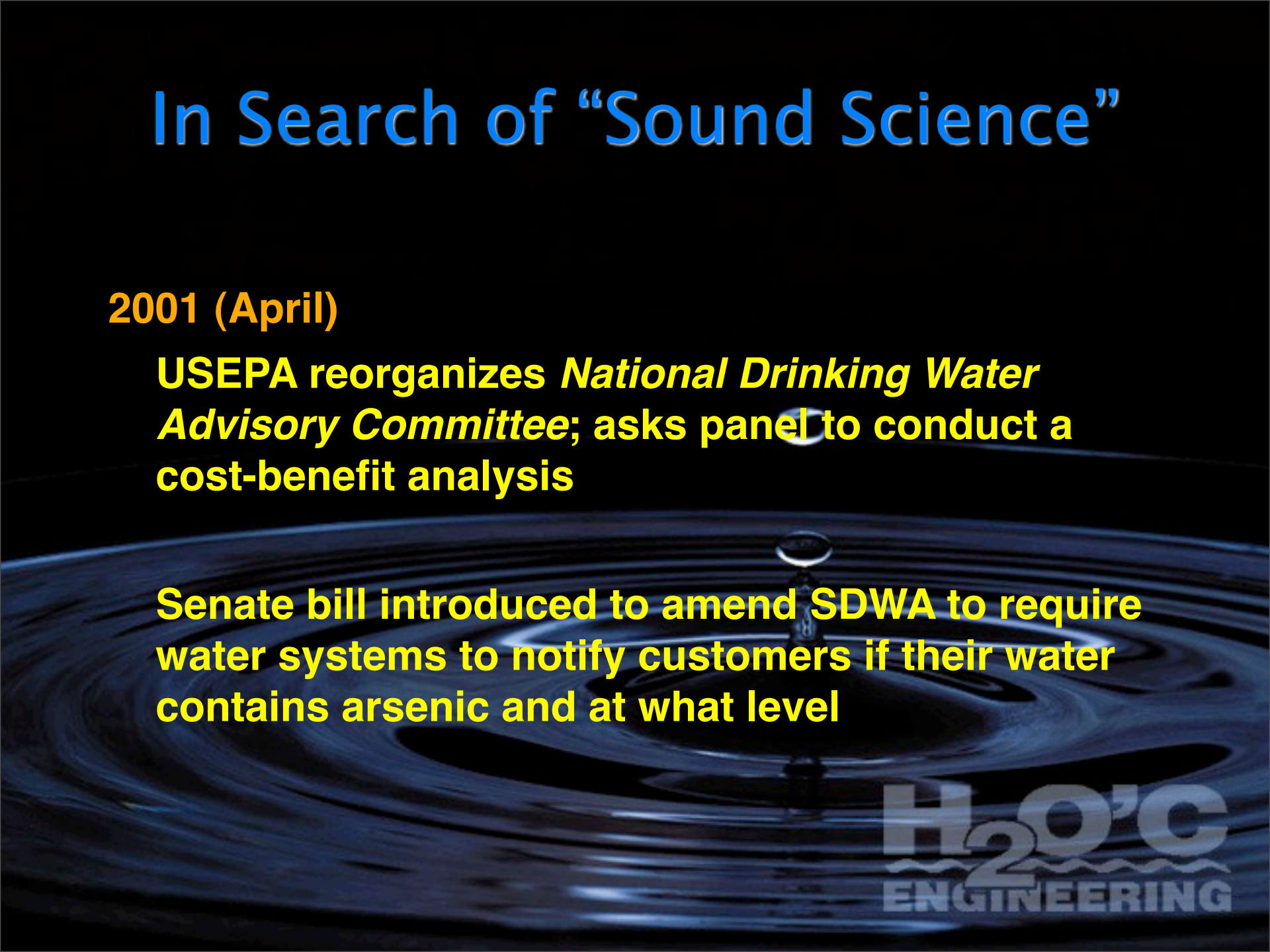
In Search of "Sound Science"

2001 (April)

USEPA reorganizes *National Drinking Water Advisory Committee*; asks panel to conduct a cost-benefit analysis

Senate bill introduced to amend SDWA to require water systems to notify customers if their water contains arsenic and at what level



From the Frying Pan...

2001 (September)

NAS-NRC releases updated arsenic risk report:

risks of bladder and lung cancer from arsenic in drinking water were previously underestimated

increased evidence that arsenic causes high blood pressure and diabetes

panel estimates that 3 μg/l of arsenic in drinking water would pose a 1 in 1,000 risk of bladder or lung cancer

H2PC ENGINEERING

Back to Square 10

2001 (October)

USEPA Administrator rescinds March decision; embraces 10 *µ*g/l MCL

Potential for future MCL reduction to 3 *µ*g/l

H2O'C ENGINEERING

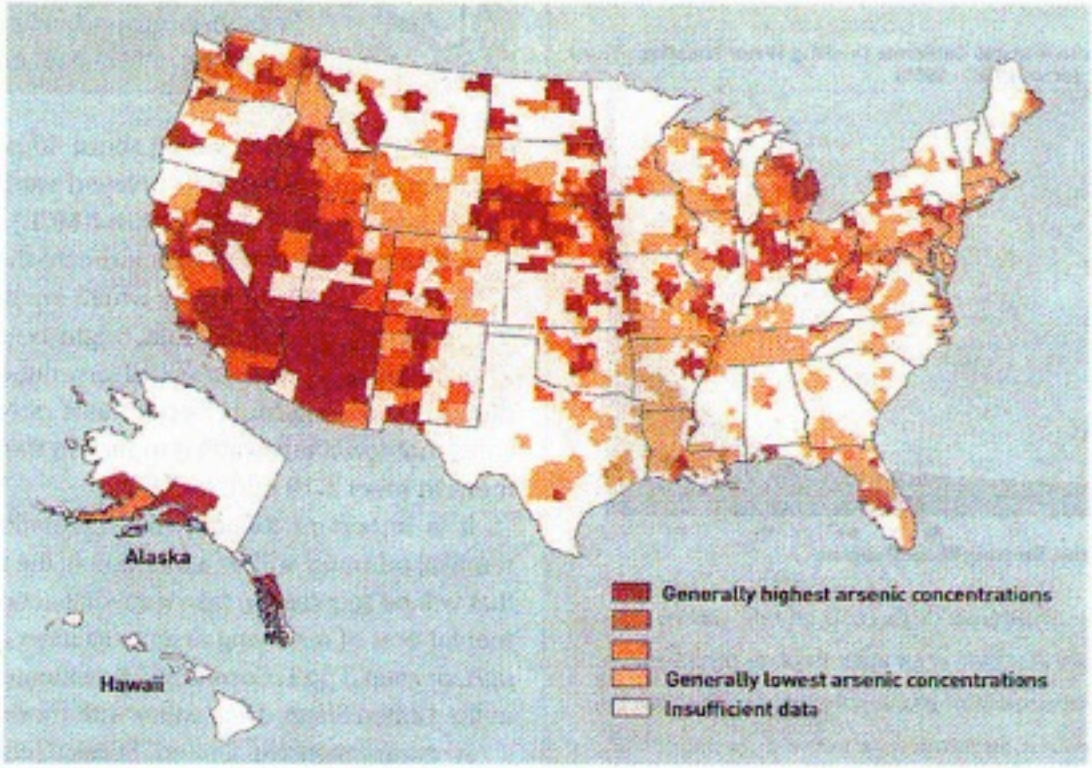
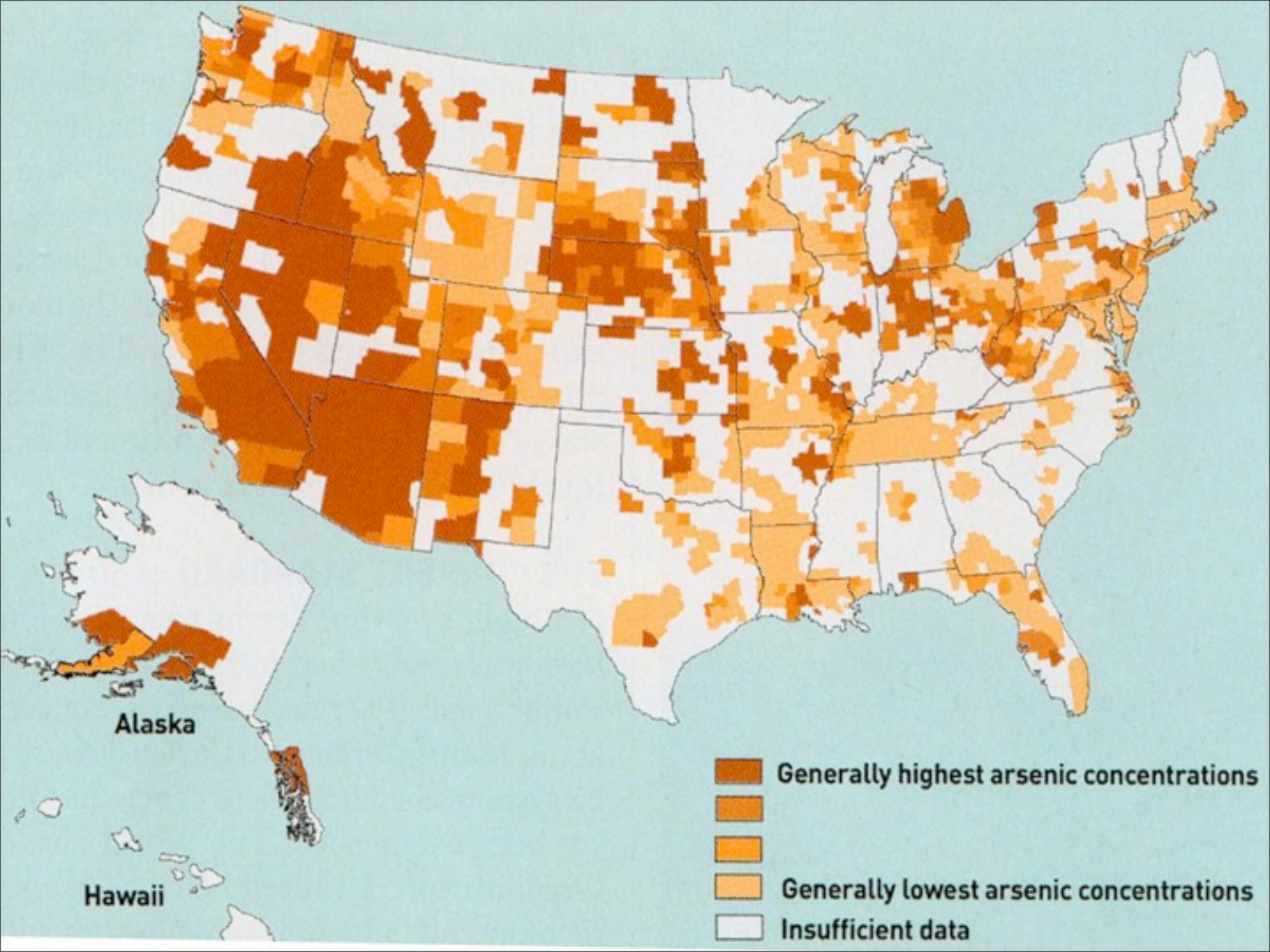


Image courtesy of United States Geological Survey

Arsenic in Drinking Water

Part 3: Occurrence of Arsenic in U.S. Waters


Alaska
Hawaii
Generally highest arsenic concentrations
Generally lowest arsenic concentrations
Insufficient data

Utilities Affected

5,125 groundwater systems < 10,000

75% already have treatment

180 groundwater systems > 10,000

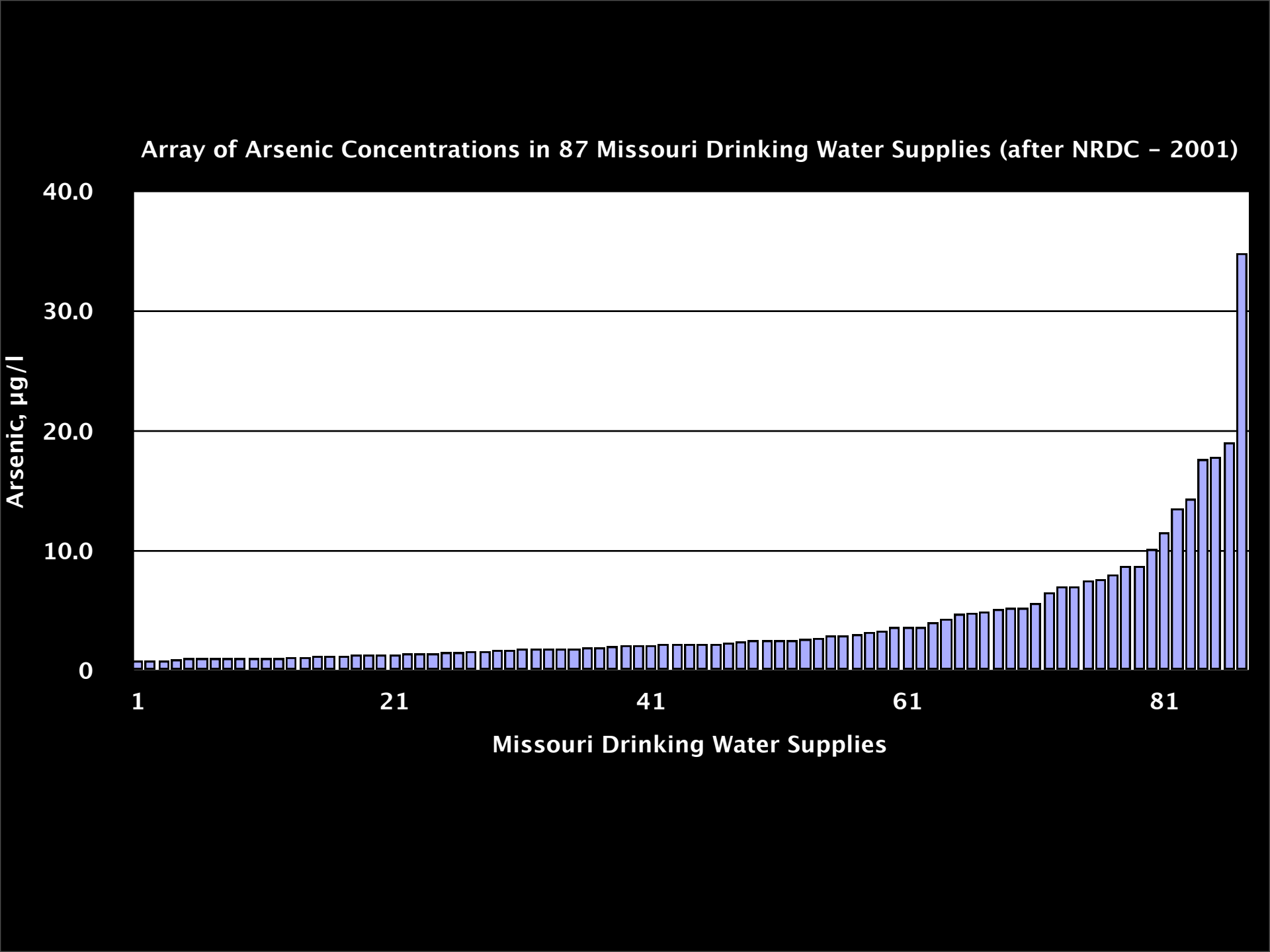
Primarily western states:

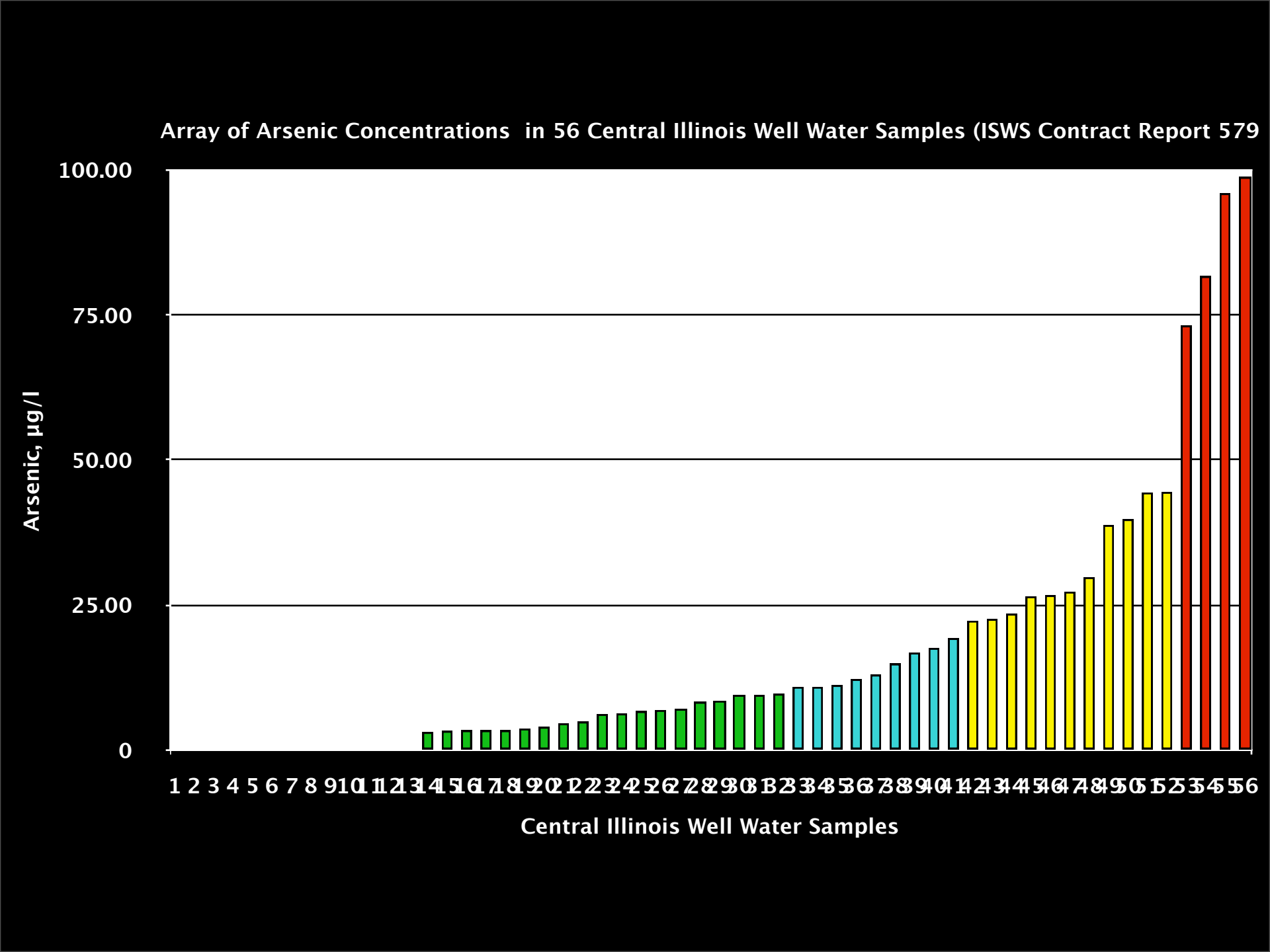
New Mexico, Nevada, California, Utah, Idaho, Oregon

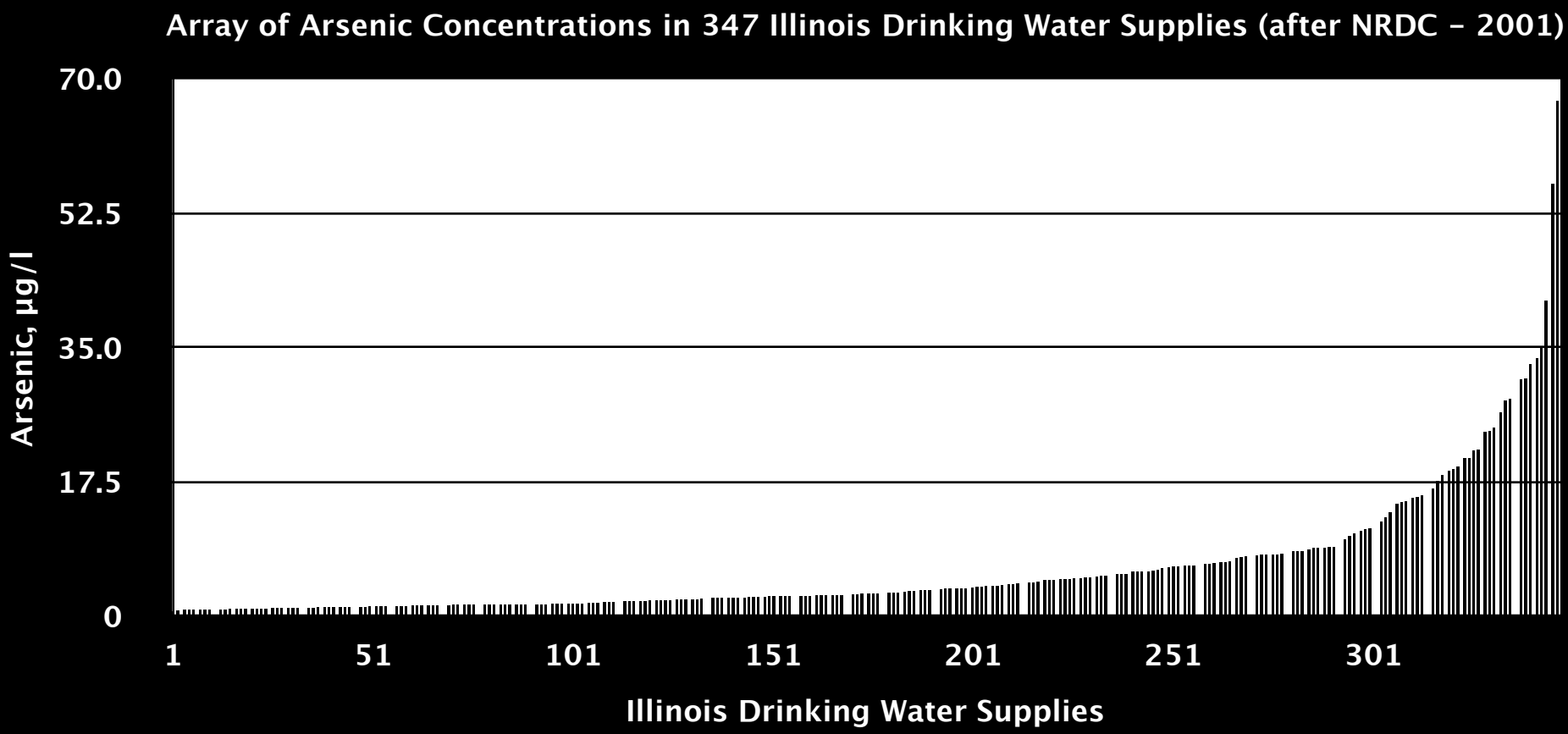
Midwest:

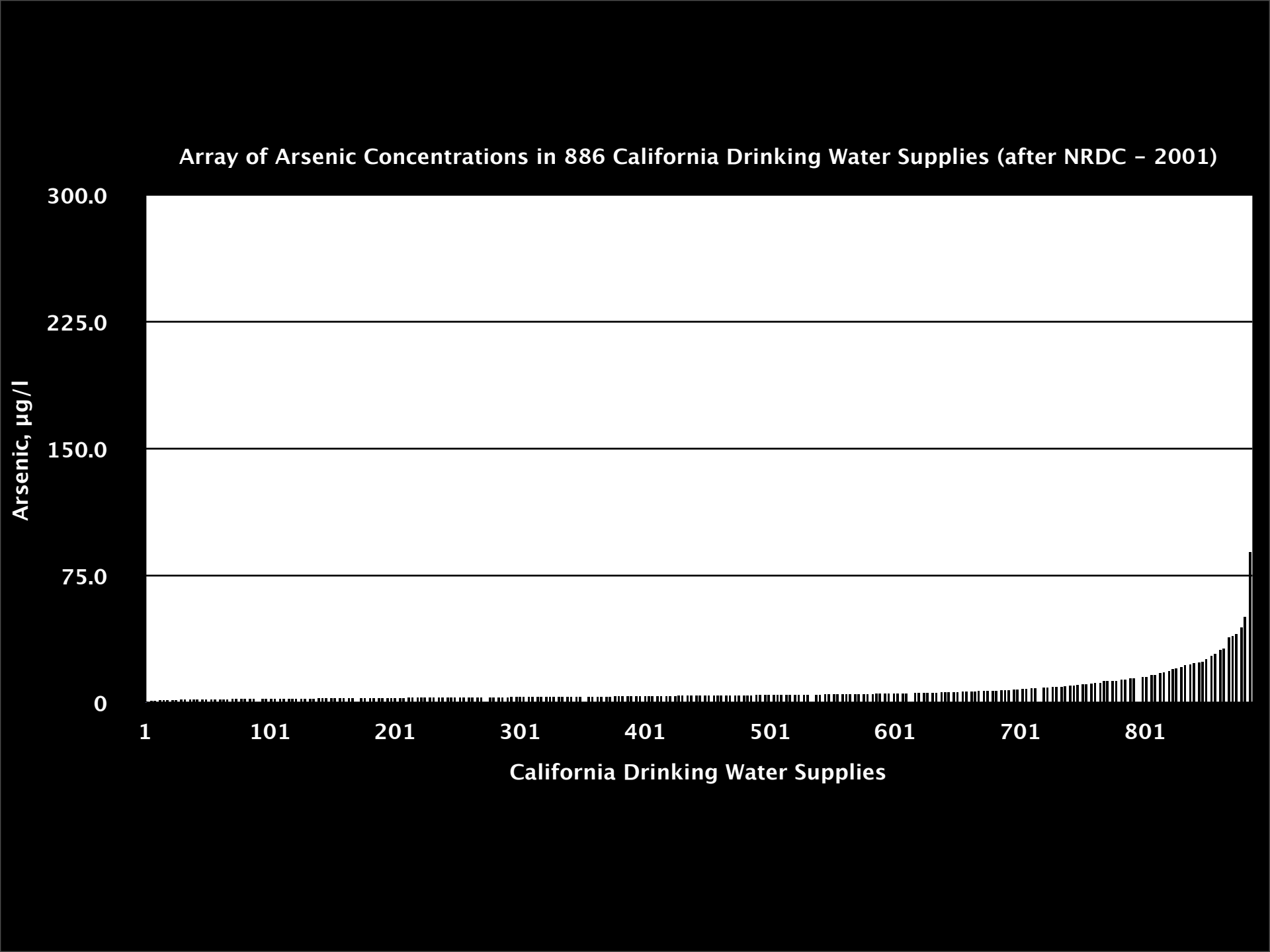
Nebraska, Illinois, Indiana, Michigan

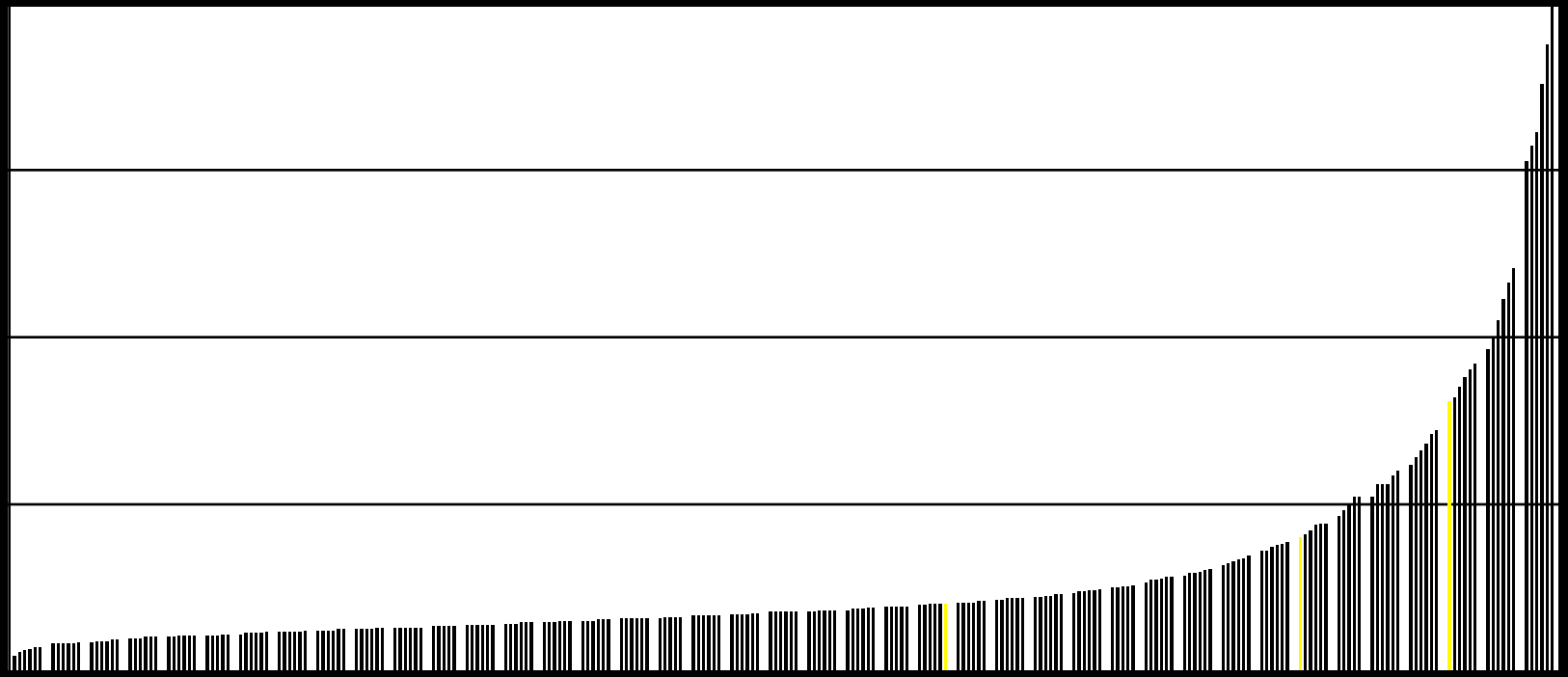
H2O'C ENGINEERING


Array of Arsenic Concentrations in 87 Missouri Drinking Water Supplies (after NRDC – 2001)
40.0
30.0
20.0
10.0
0
Arsenic, µg/l
1
21
41
61
81
Missouri Drinking Water Supplies

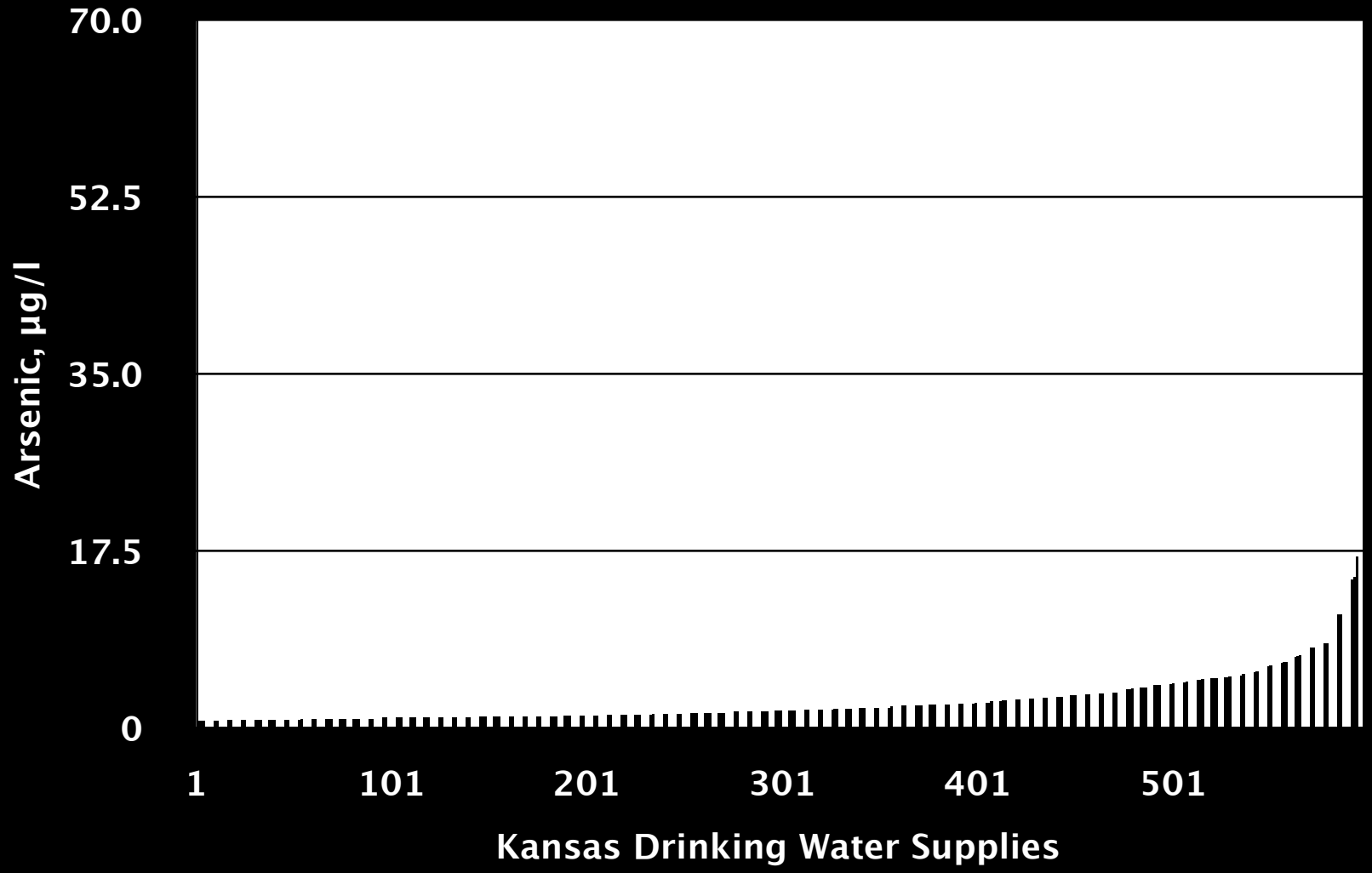

Array of Arsenic Concentrations in 56 Central Illinois Well Water Samples (ISWS Contract Report 579
100.00
75.00
50.00
25.00
0
Arsenic, µg/l
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56
Central Illinois Well Water Samples

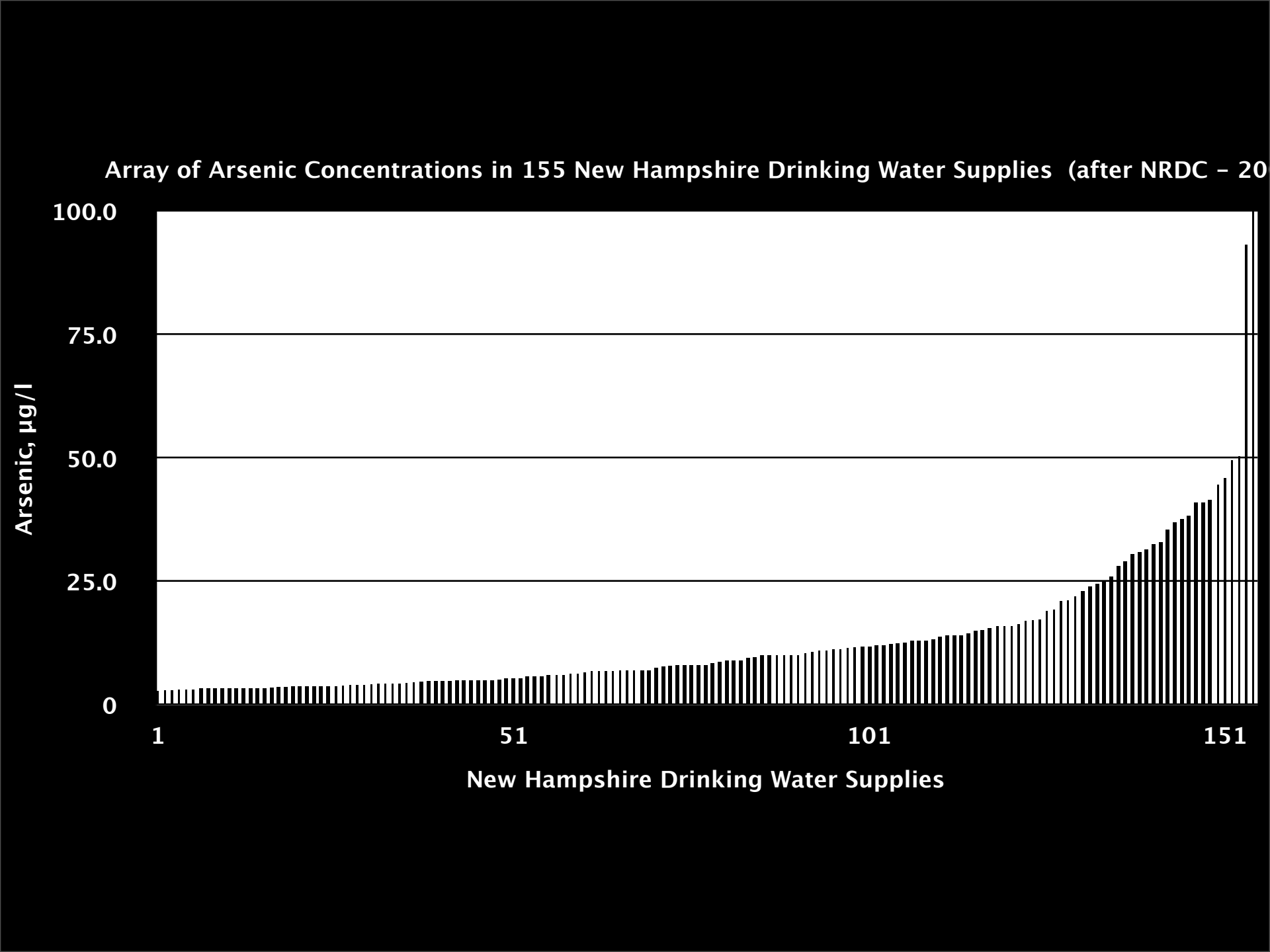

Array of Arsenic Concentrations in 347 Illinois Drinking Water Supplies (after NRDC – 2001)
70.0
52.5
35.0
17.5
0
Arsenic, µg/l
1
51
101
151
201
251
301
Illinois Drinking Water Supplies

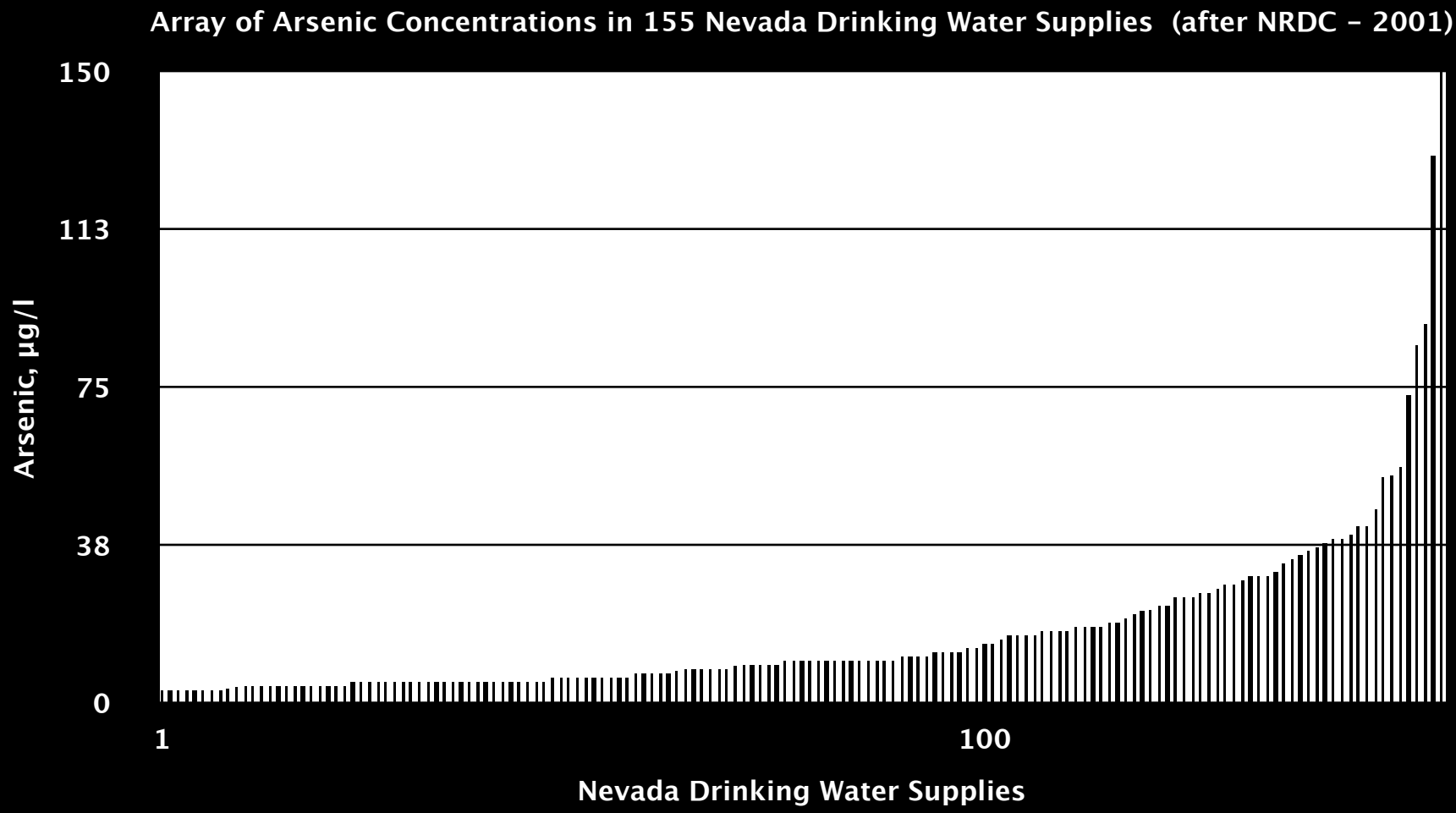

Array of Arsenic Concentrations in 886 California Drinking Water Supplies (after NRDC – 2001)
300.0
225.0
150.0
75.0
0
Arsenic, µg/l
1
101
201
301
401
501
601
701
801
California Drinking Water Supplies

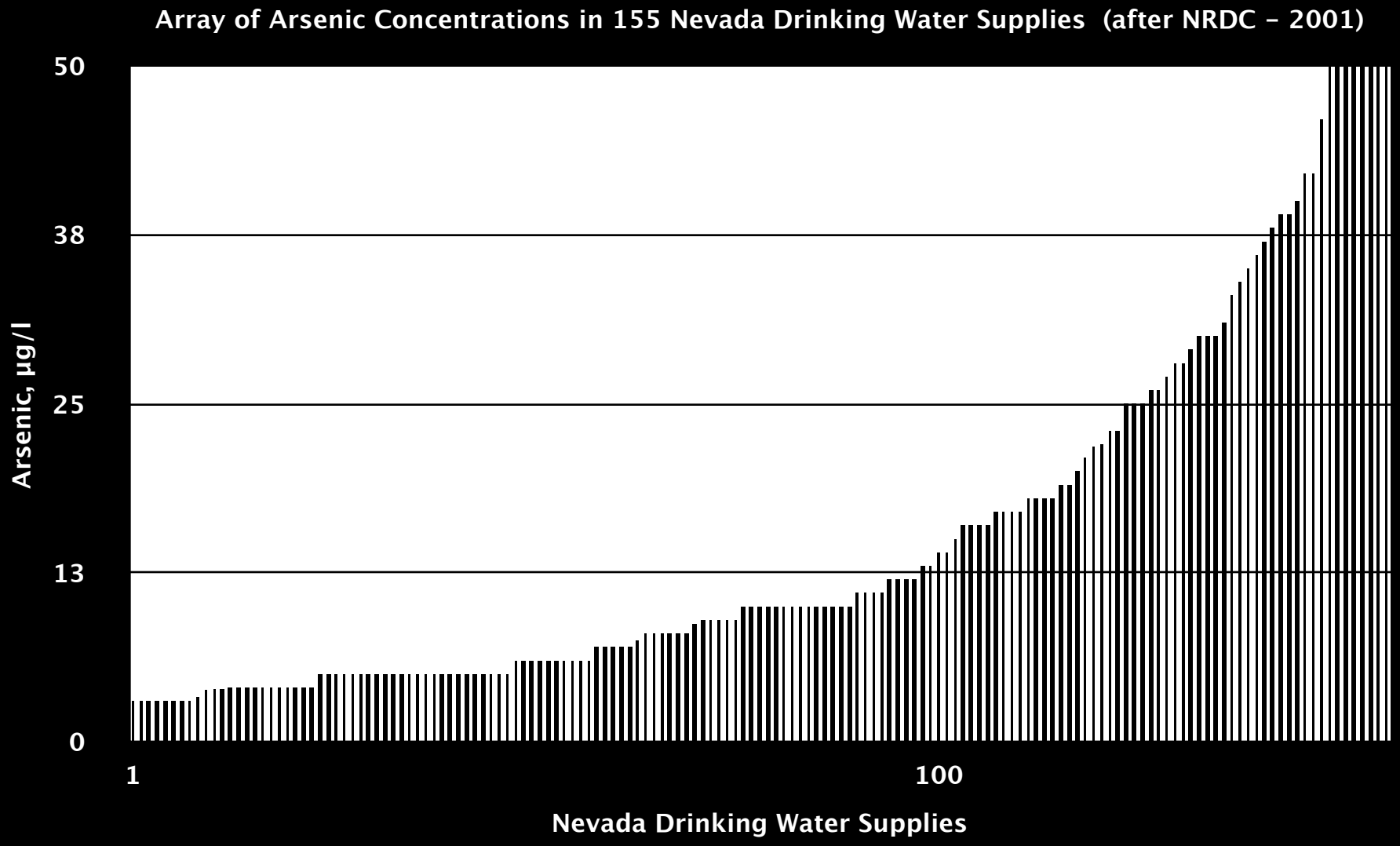


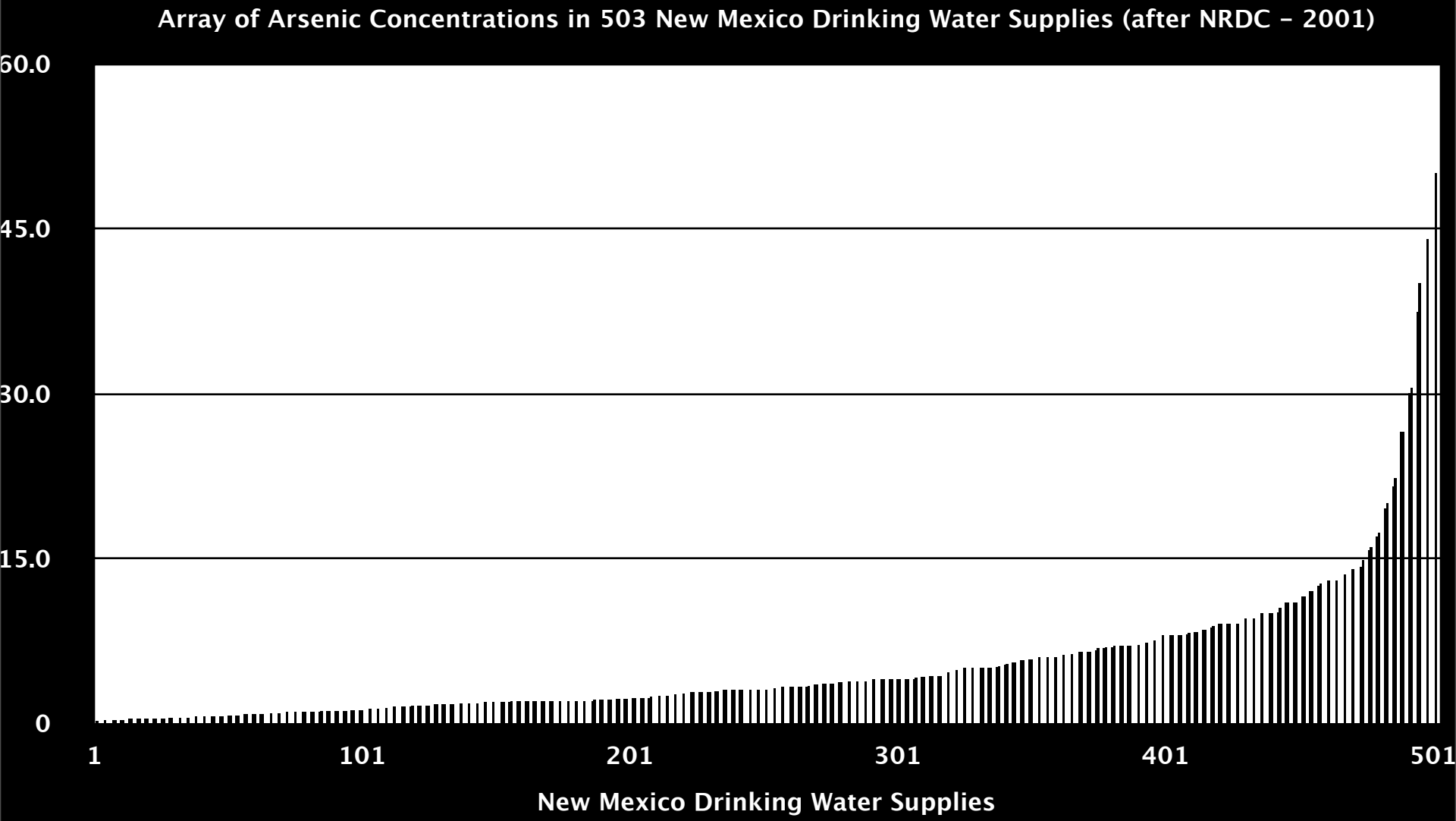
Array of Arsenic Concentrations in 597 Kansas Drinking Water Supplies (after NRDC 2000)

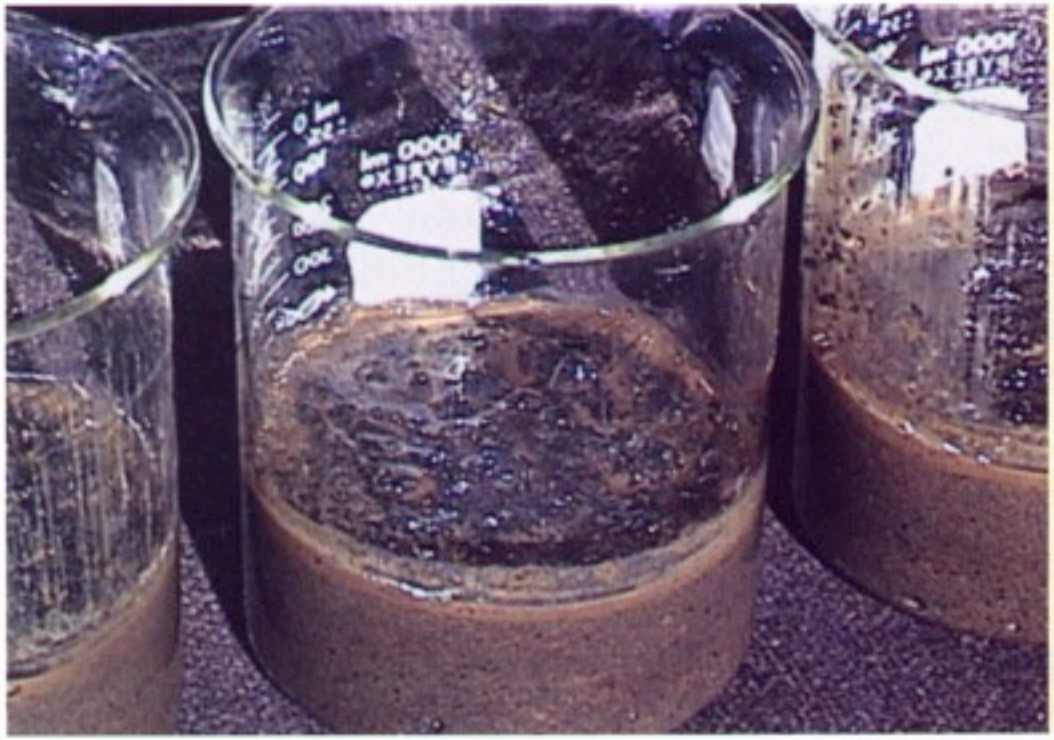



Array of Arsenic Concentrations in 155 New Hampshire Drinking Water Supplies (after NRDC – 20
100.0
75.0
50.0
25.0
0
Arsenic, µg/l
1
51
101
151
New Hampshire Drinking Water Supplies


Array of Arsenic Concentrations in 155 Nevada Drinking Water Supplies (after NRDC – 2001)
150
113
75
38
0
Arsenic, µg/l
1
100
Nevada Drinking Water Supplies


Array of Arsenic Concentrations in 155 Nevada Drinking Water Supplies (after NRDC – 2001)
50
38
25
13
0
Arsenic, µg/l
1
100
Nevada Drinking Water Supplies


Array of Arsenic Concentrations in 503 New Mexico Drinking Water Supplies (after NRDC – 2001)
60.0
45.0
30.0
15.0
0
1
101
201
301
401
501
New Mexico Drinking Water Supplies



Studies have confirmed that arsenic is removed effectively by precipitation with iron.

Arsenic in Drinking Water

Part 4: Arsenic Removal Methods

Arsenic Removal Technologies (as confounded by USEPA)

Precipitative Processes

- **Coagulation/Filtration,** a.k.a.
  - Iron/Manganese Oxidation
  - Coagulation- Assisted Microfiltration
  - Enhanced Coagulation
- **Lime Softening**

Adsorptive Processes

- **Activated Alumina**
  - Iron Oxide-Coated Sand
- **Ion Exchange**

Membrane (Processes

- Microfiltration
- Ultrafiltration
- Nanofiltreation
- **Reverse Osmosis**
- **Electrodialysis Reversal**

Alternative (Adsorptive) **Technologies**

- Oxidation Filtration
- Sulfur-Modified Iron
- Granular Ferric Hydroxide
- Iron Filings

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USEPA-Designated
Best Available Treatment Processes

Conventional Treatment

Aeration / Filtration	Adsorption on Fe, Mn Oxides
Coagulation/Filtration	Adsorption on Aluminum Oxides
Lime Softening	Adsorption on Fe, Al, Mg Oxides

Adsorption Media

Activated Alumina	Adsorption on AlO_2 at pH 6
Anion Exchange	Strongly Basic Anion Exchange Resin

Membrane Processes

Reverse Osmosis; Electrodialysis Reversal

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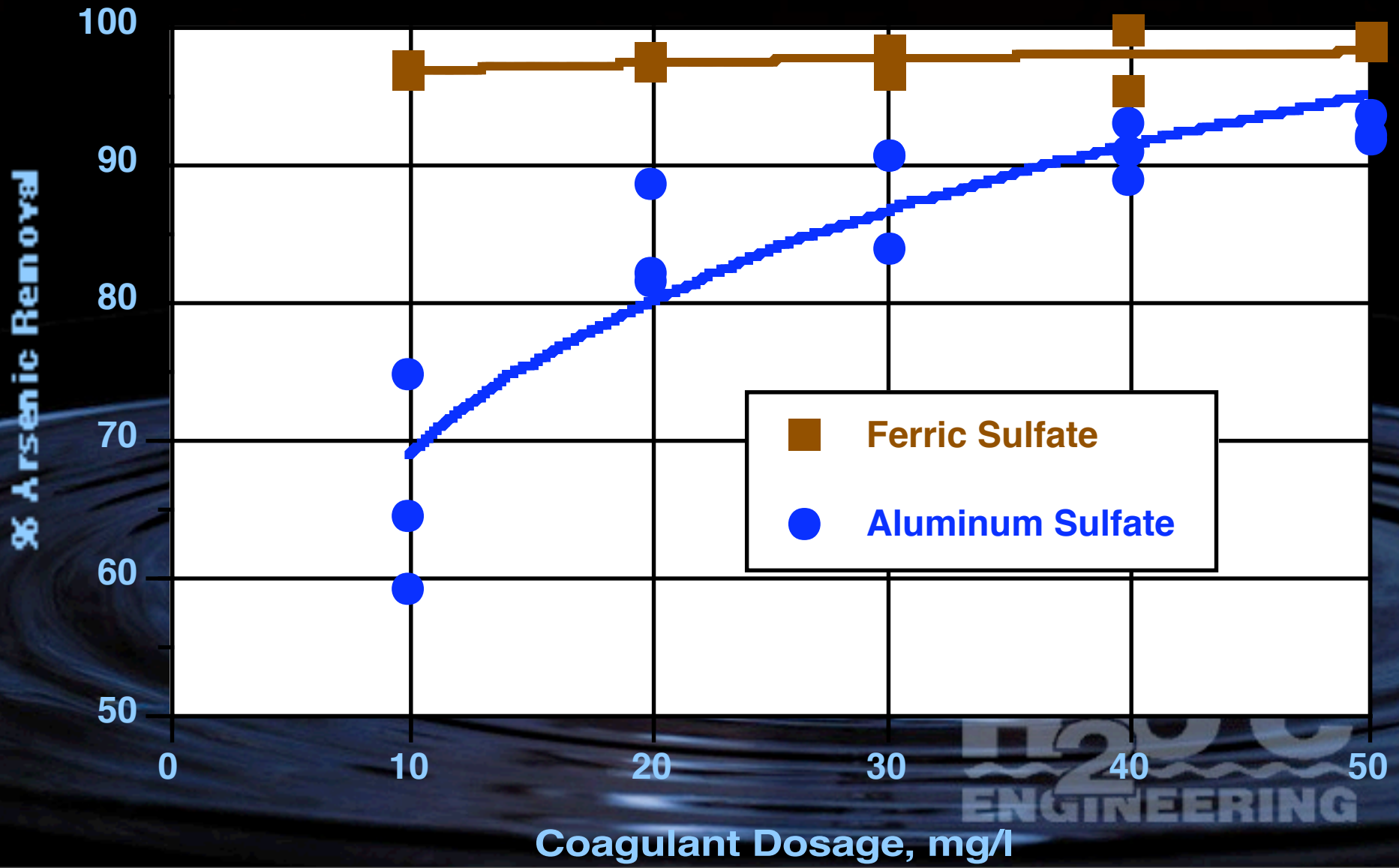
Arsenic Removal by Coagulation and Filtration

(Gulledge and O'Connor, J.AWWA, 1973; 65, 8, 548)

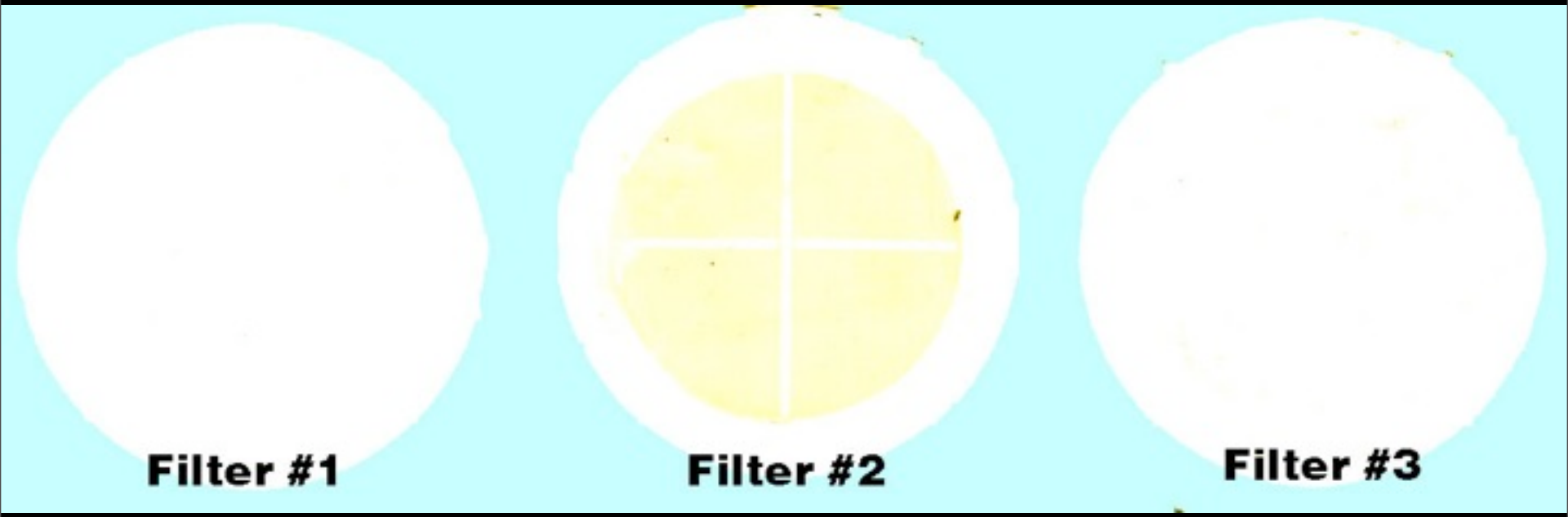


Removal of Fe, Mn from Groundwater: Aeration, KMnO4, Greensand Filters

NSF
CAIROX

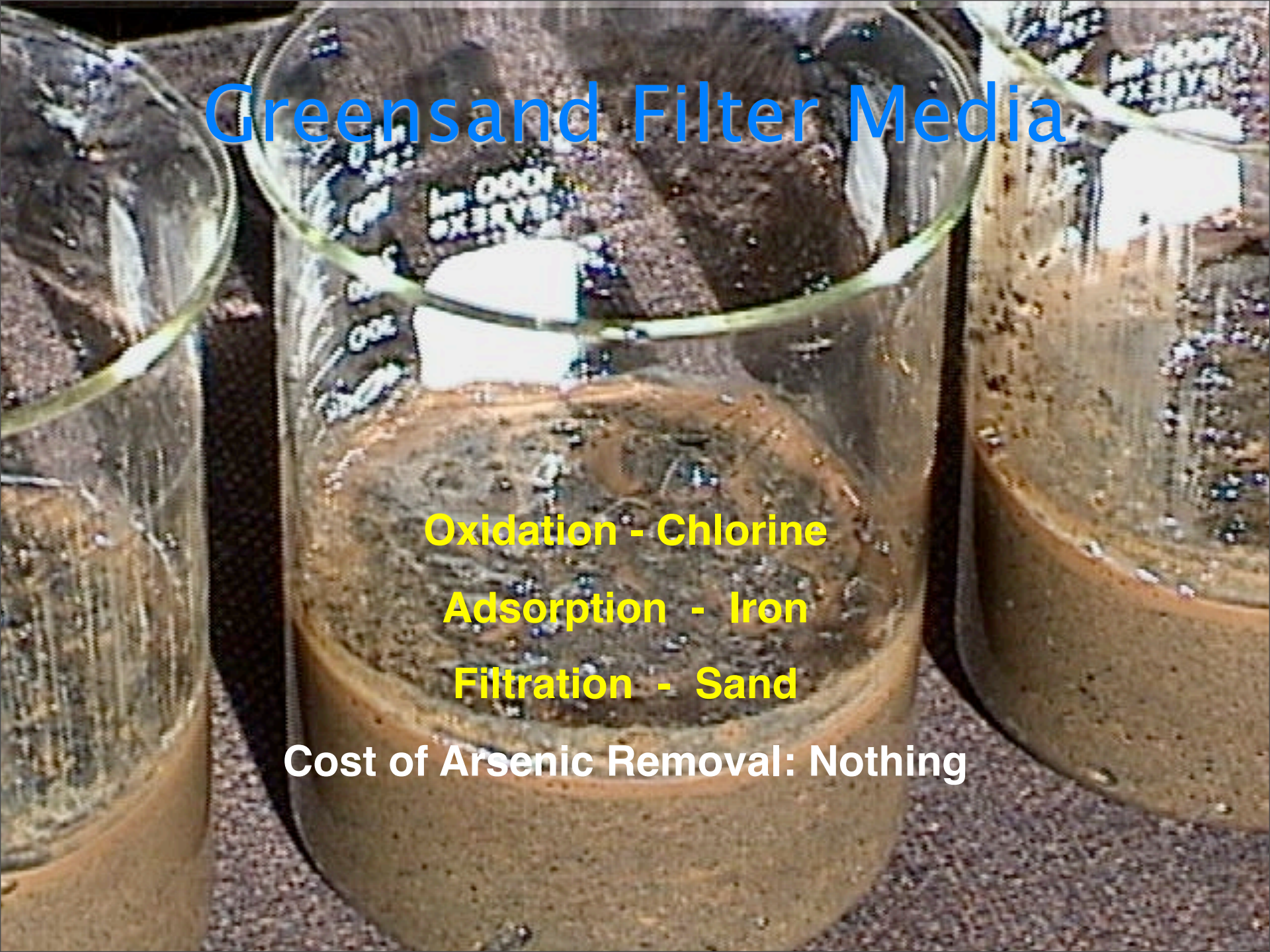
Arsenic
reduced
from 20 to
< 3 µg/l

Monitoring Filter Performance



Greensand from Filter
Mudball

Greensand Filter Media



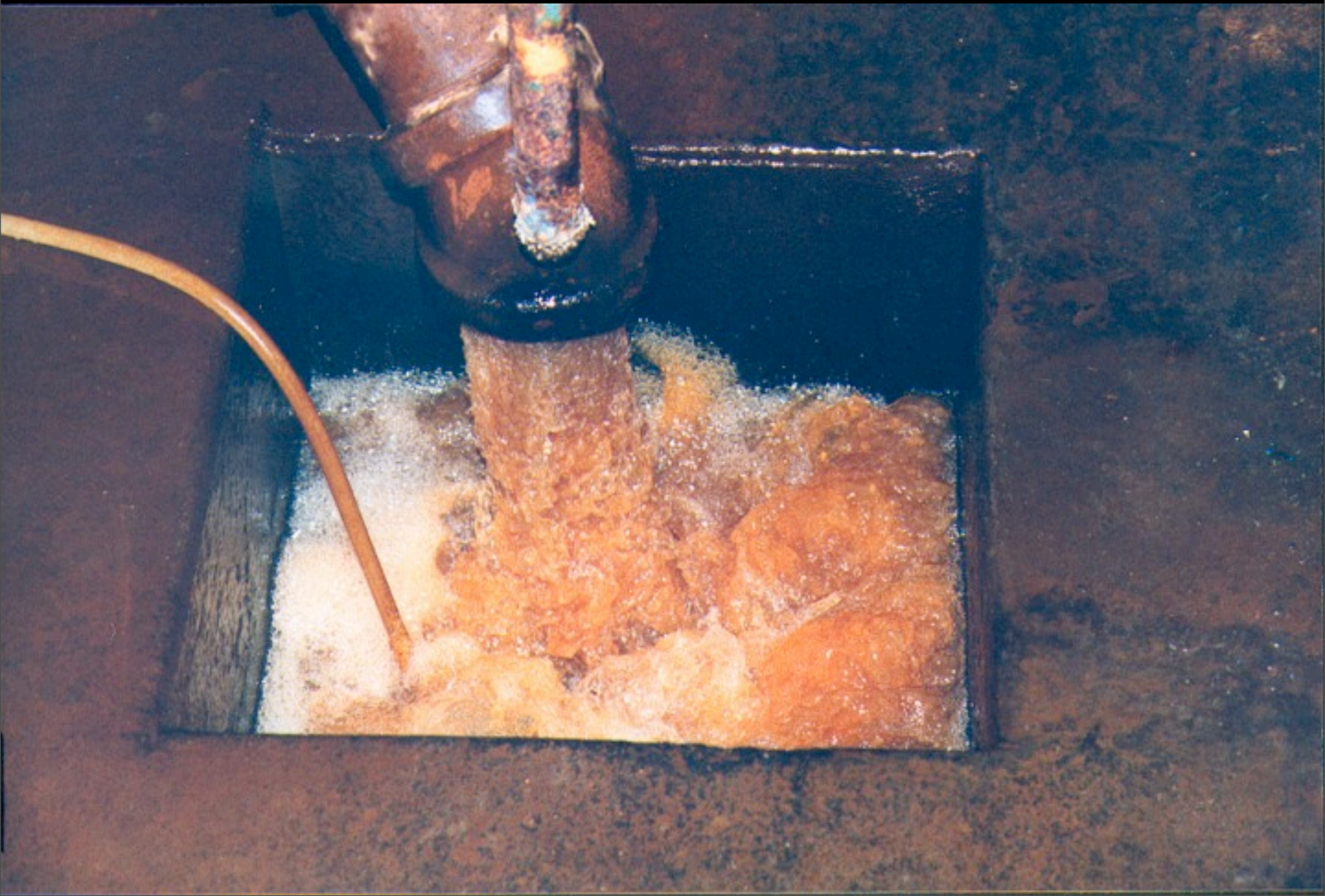
Oxidation - Chlorine

Adsorption - Iron

Filtration - Sand

Cost of Arsenic Removal: Nothing

Arsenic in Filter Backwash



Backwash Water Disposal

Arsenic recovered in $Fe(OH)_3$ sludge

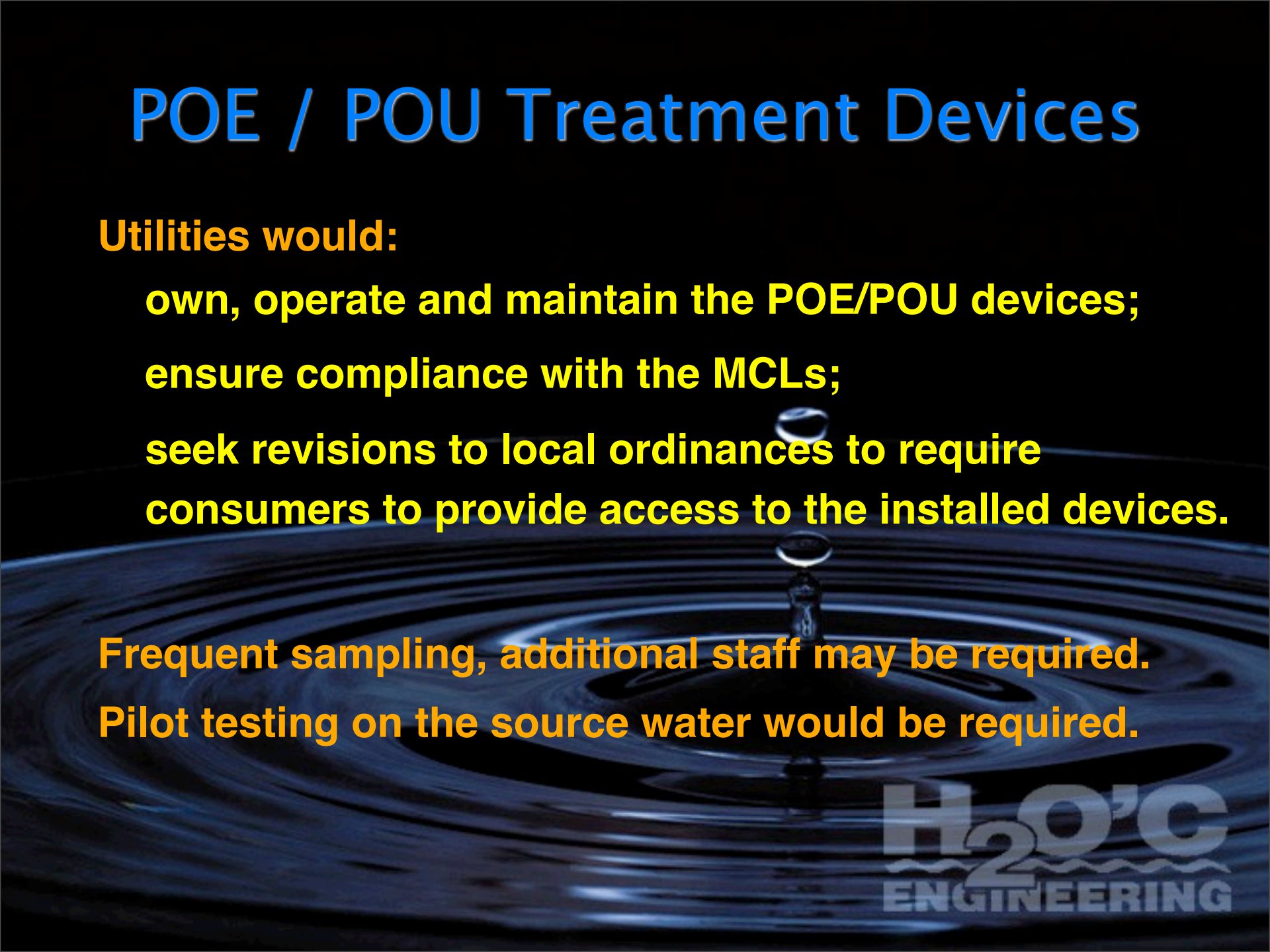
POE / POU Treatment Devices

Utilities would:

- **own, operate and maintain the POE/POU devices;**
- **ensure compliance with the MCLs;**
- **seek revisions to local ordinances to require consumers to provide access to the installed devices.**

Frequent sampling, additional staff may be required.

Pilot testing on the source water would be required.



USEPA Places Limitations on Small Communities

Coagulation / filtration, lime softening, reverse osmosis and electrodialysis reversal are not designated as BAT for systems with fewer than 500 service connections.

USEPA has defined "small system compliance technologies (SSCTs)" limiting arsenic removal technology for smaller communities based on the presumption that they will not be able to provide "appropriate" operation and maintenance.

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Proprietary Media for Arsenic

'Package plants' with proprietary media:

Filtronics "Electromedia"
media backwashed and continually reused

General Filter's GFH (granular ferric hydroxide)
media replaced after exhaustion

University of Missouri-Columbia (Dr. Stanley Manahan)
triple reverse burn (TRB) char
prepared from a sub-bituminous coal

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Arsenic Removal Costs

USEPA estimated costs to meet 10 µg/l MCL

Capital Cost:	**$900 million***
Annual O&M:	**$118 million**
Annual Monitoring & Administration:	**$2.7 million**
Average Annual Water Bill Increase:	**$32**
(all 4,100 affected systems)	
Annual Water Bill Increase:	**$58-327**
(~2,500 affected systems serving < 3,300)	

*Does not consider other treatment benefits;
selection of alternate sources;
use of least costly treatment processes.

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Arsenic in Drinking Water

Summary

New Arsenic MCL: 10 µg/l

Compliance Date: January 23, 2006

Potential Health Effects: Skin damage; diabetes; problems with circulatory systems; possible increased risk of lung/bladder cancer

Sources of Arsenic in Drinking Water: Mining, erosion of natural deposits; leaching of CCA-treated lumber; runoff from orchards; glass & electronics production wastes

Arsenic Removal Technologies: Precipitative, Adsorptive, Membrane Processes, Alternative (GFH, SMI)

www.epa.gov/safewater:

- **Implementation Guidance for the Arsenic Rule**
- **Arsenic Small System's Treatment Technology Design Manual (draft)**
- **Draft Guidance for Implementing a POU or POE Treatment Strategy**
- **Technologies and Costs for Removing Arsenic from Drinking Water**
- **Using DWSRF Funds to Comply with the New Arsenic Rule**

Dr. John T. O'Connor, PE

$H_2O'C$ Engineering 2401 Tahoe Court Columbia, MO 65203-1444 www.h2oc.com

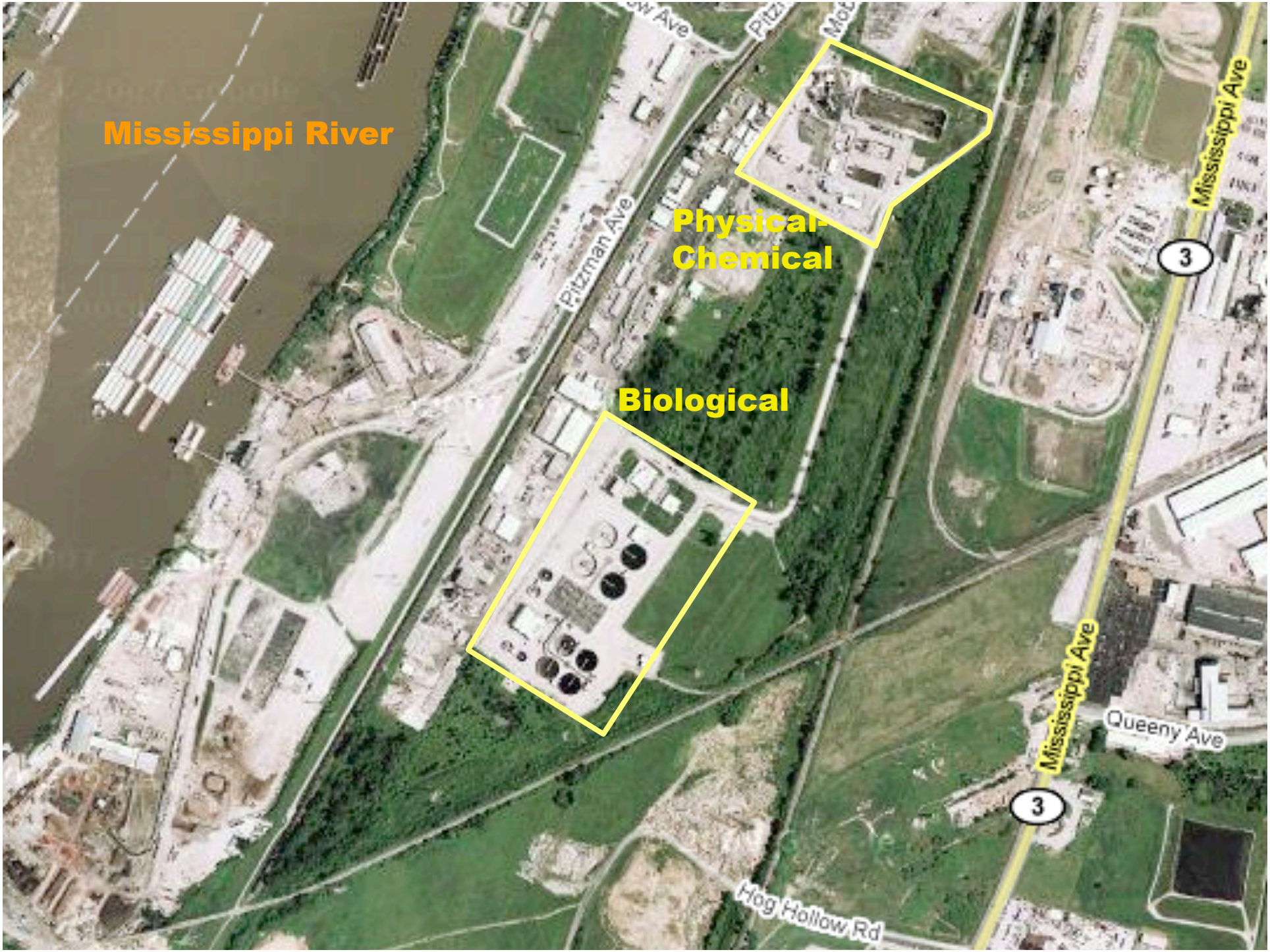
877-22-WATER

573-446-5595

john@h2oc.com

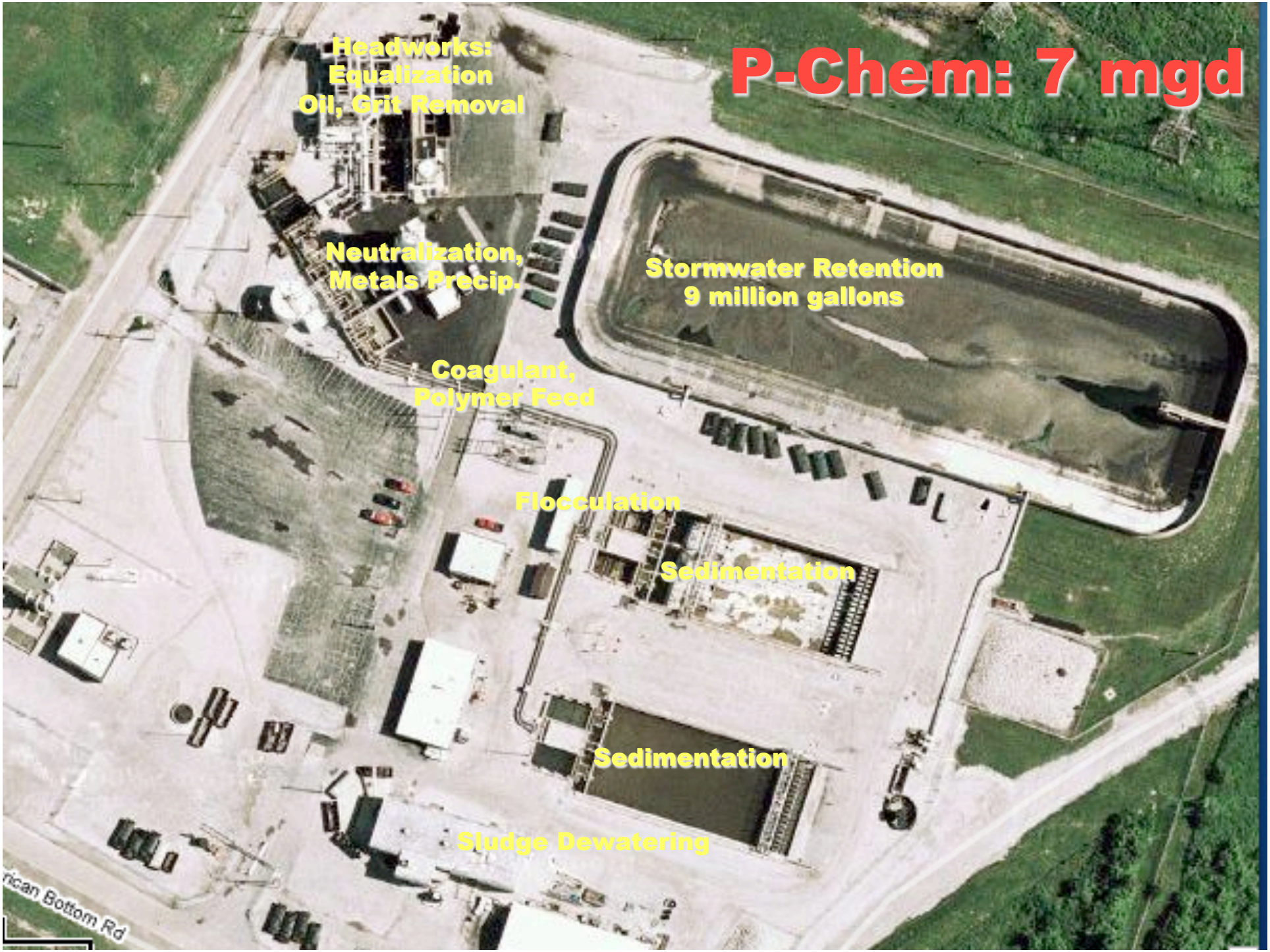
Industrial Waste Pretreatment
Equalization, Neutralization, Metals Removal
A Case Study:
American Bottoms Wastewater Treatment Plant
1 American Bottom Road, Sauget, Illinois
Dr. John T. O'Connor, PE
H2O'C

290C
Missouri
Illinois
St. Louis
Kosciusko
7th Blvd
American Bottoms
Wastewater Treatment
Plant
Sauget
Mississippi Ave
Falling Springs Rd
Sauget
3
B

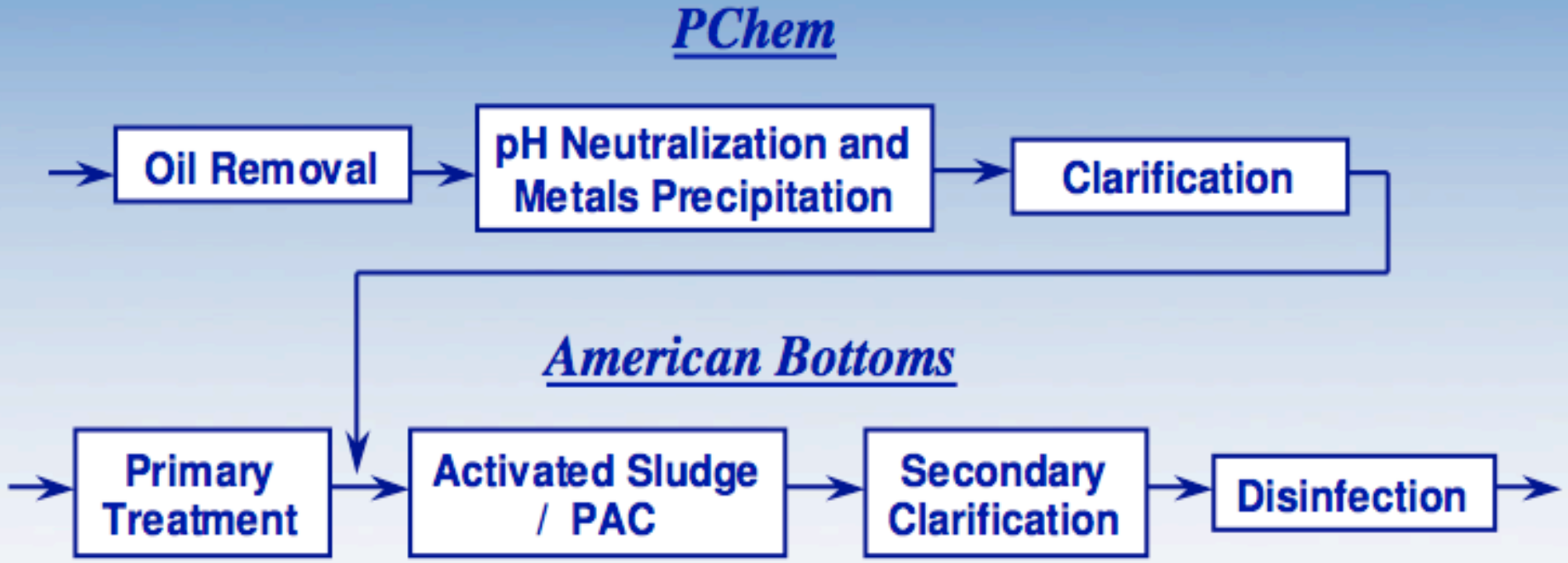

Mississippi River
Physical-
Chemical
Biological
Pitzman Ave
Mississippi Ave
Mississippi Ave
3
3
Queeny Ave
Hog Hollow Rd

26 MGD
Biological Treatment:
•Primary Sedimentation
•Activated Sludge with PAC
•Nitrification
•Secondary Sedimentation
•Disinfection

7 MGD
Physical-Chemical Plant
•Oil, Grit Removal
•Equalization
•Neutralization, Metals Removal
•Clarification
•Sludge Dewatering & Disposal
Mobile St
American Bottom Rd


P-Chem: 7 mgd
Headworks:
Equalization
Oil, Grit Removal
Neutralization,
Metals Precip.
Stormwater Retention
9 million gallons
Coagulant,
Polymer Feed
Flocculation
Sedimentation
Sedimentation
Sludge Dewatering
rican Bottom Rd

American Bottoms Wastewater Treatment



Waste Contributors

Solutia (formerly Monsanto)

Sulfuric, Hydrochloric, Phosphoric, Formic Acids

Ammonia, Aniline, Benzene, Xylene, Ethylene Glycol

Methylethyl ketone, Methylisobutyl ketone,

Monochlorobenzene, Orthodichlorobenzene,

Orthonitrophenol, Paranitrophenol

Waste Contributors

Cerro Copper

#2 Fuel Oil

Gasoline

Kerosene

Trichloroethylene

Ethyl Corporation

Gear Crankcase Oil

Transmission Fluid

Benzene

Isobutylene

Waste Contributors

Big River Zinc

Arsenic, Cadmium, Calcium, Manganese, Sodium

Zinc & Copper Sulfate, Sulfuric Acid

#2 Diesel Fuel, Gasoline, PCB

Potassium Permanganate, Soda Ash,

Sodium Hydrosulfide, Strontium Carbonate

Physical Properties

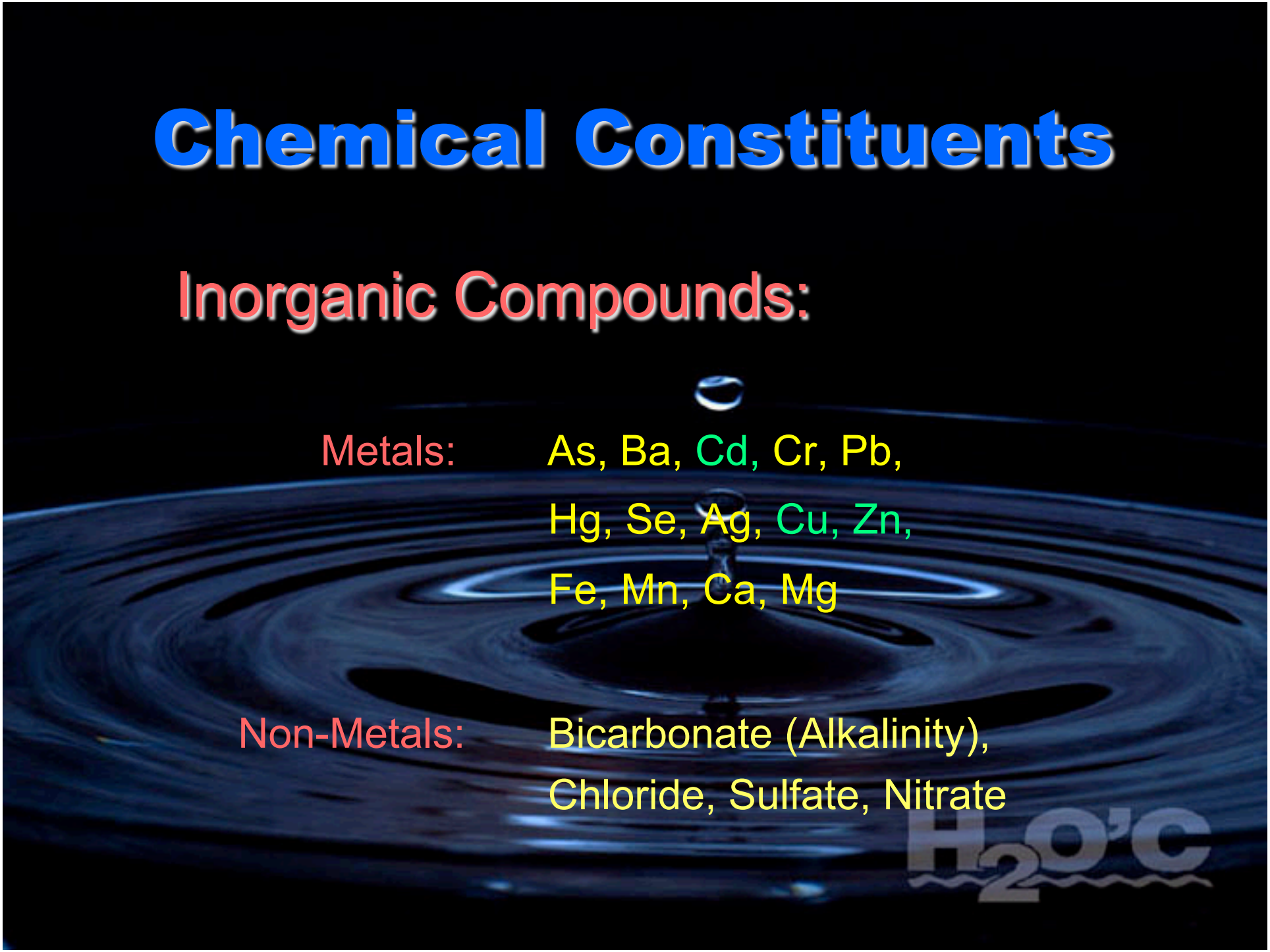
Temperature	Density, Reaction Rates
Floatables	Grease: Oils, Fats, Wax
Turbidity	Light Scattering Particles
Solids	Inorganic (sand), Organic (fiber)
Odor	Sulfides, Ammonia, Volatile Organics
Color	True (dyes), Apparent (precipitates)

Chemical Constituents

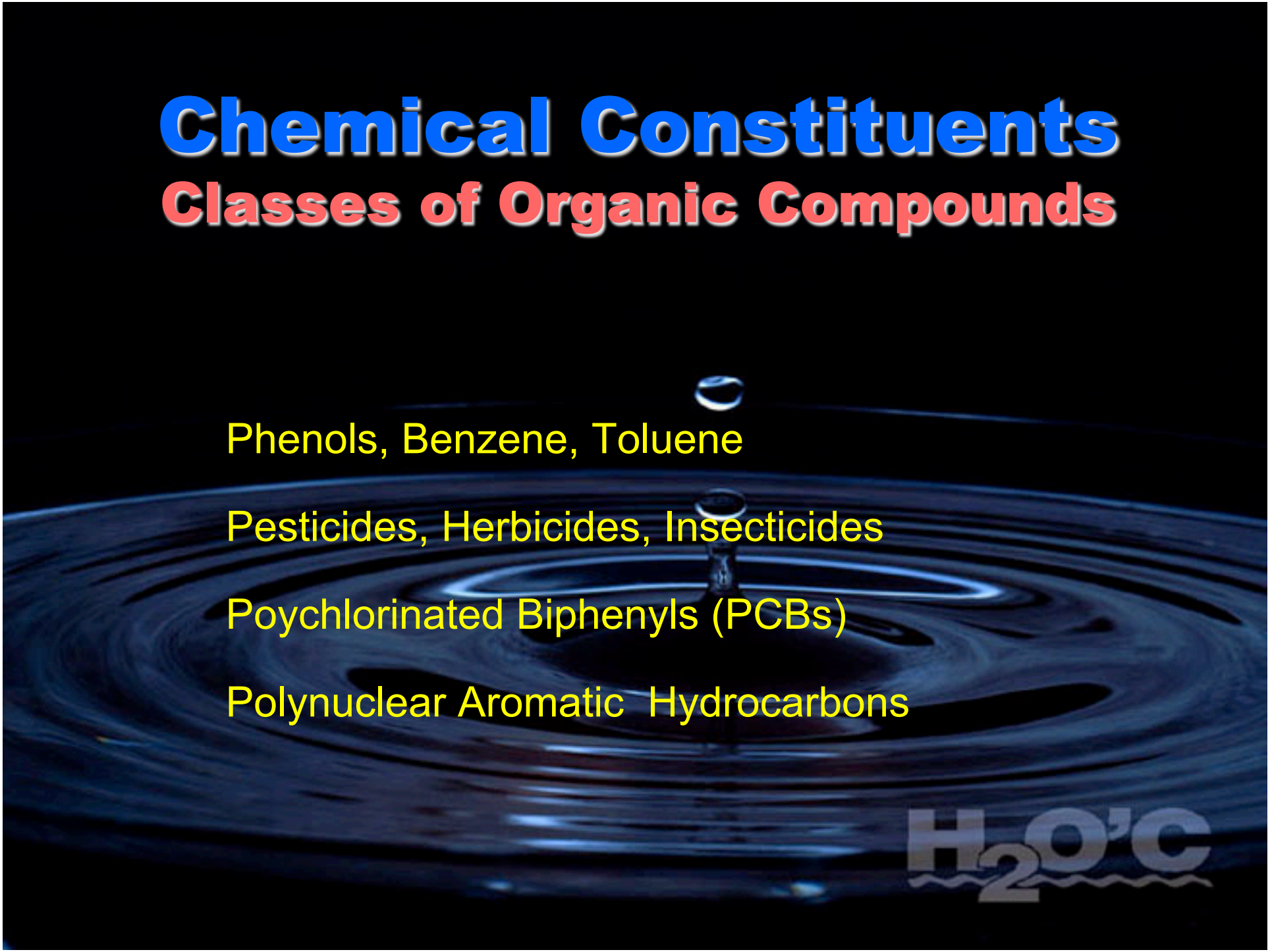
Inorganic Compounds:

Metals: As, Ba, Cd, Cr, Pb, Hg, Se, Ag, Cu, Zn, Fe, Mn, Ca, Mg

Non-Metals: Bicarbonate (Alkalinity), Chloride, Sulfate, Nitrate



Chemical Constituents
Classes of Organic Compounds



Phenols, Benzene, Toluene

Pesticides, Herbicides, Insecticides

Poychlorinated Biphenyls (PCBs)

Polynuclear Aromatic Hydrocarbons

$H_2O'C$

Municipal Wastewater

Solids:

Dissolved	500 mg/l
Suspended	200 mg/l

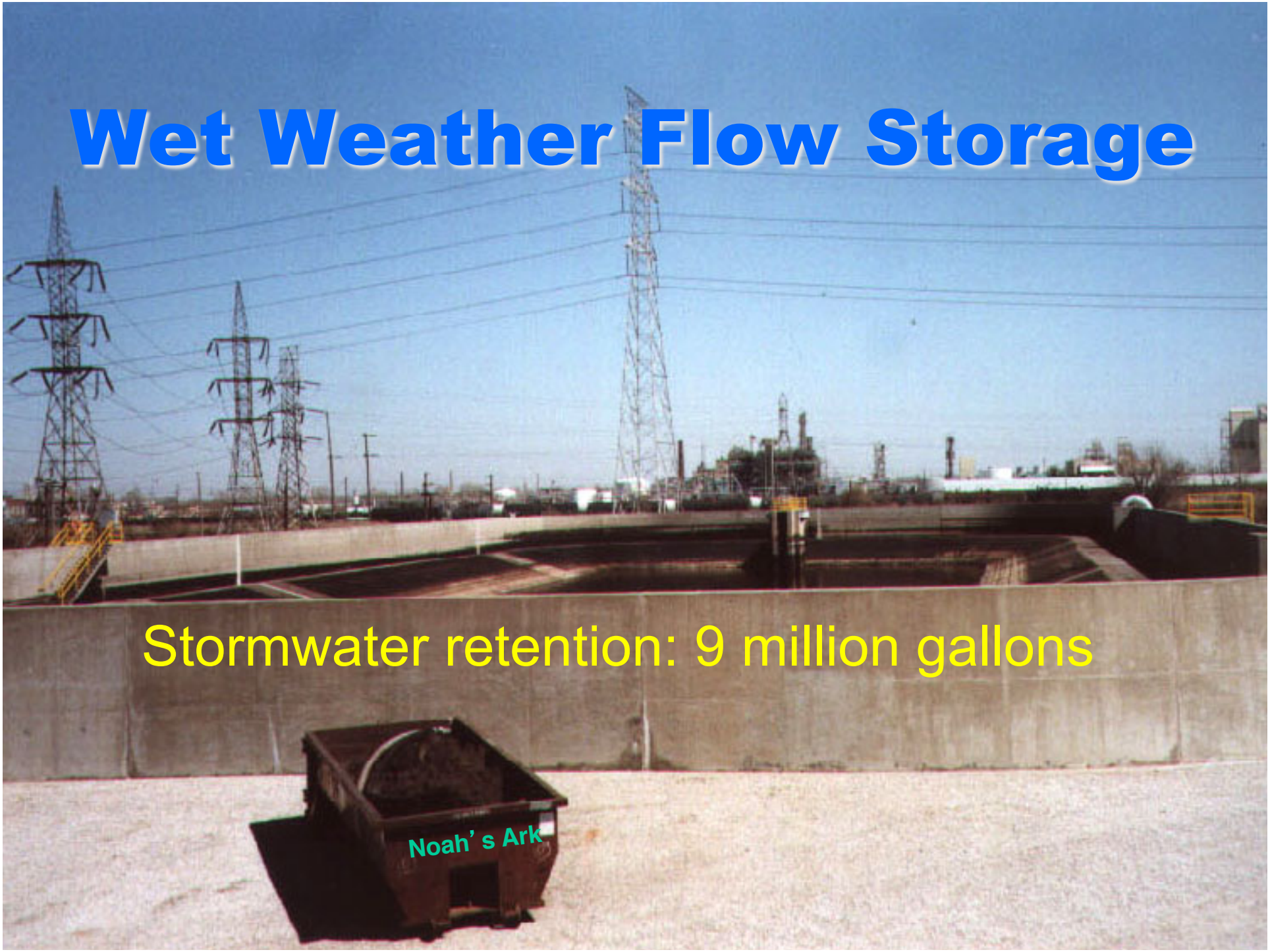
Organic Matter:

BOD 5d, 20 °C	200 mg O/l
COD	500 mg O/l
TOC	160 mg C/l

Toxic to Biological Waste Treatment

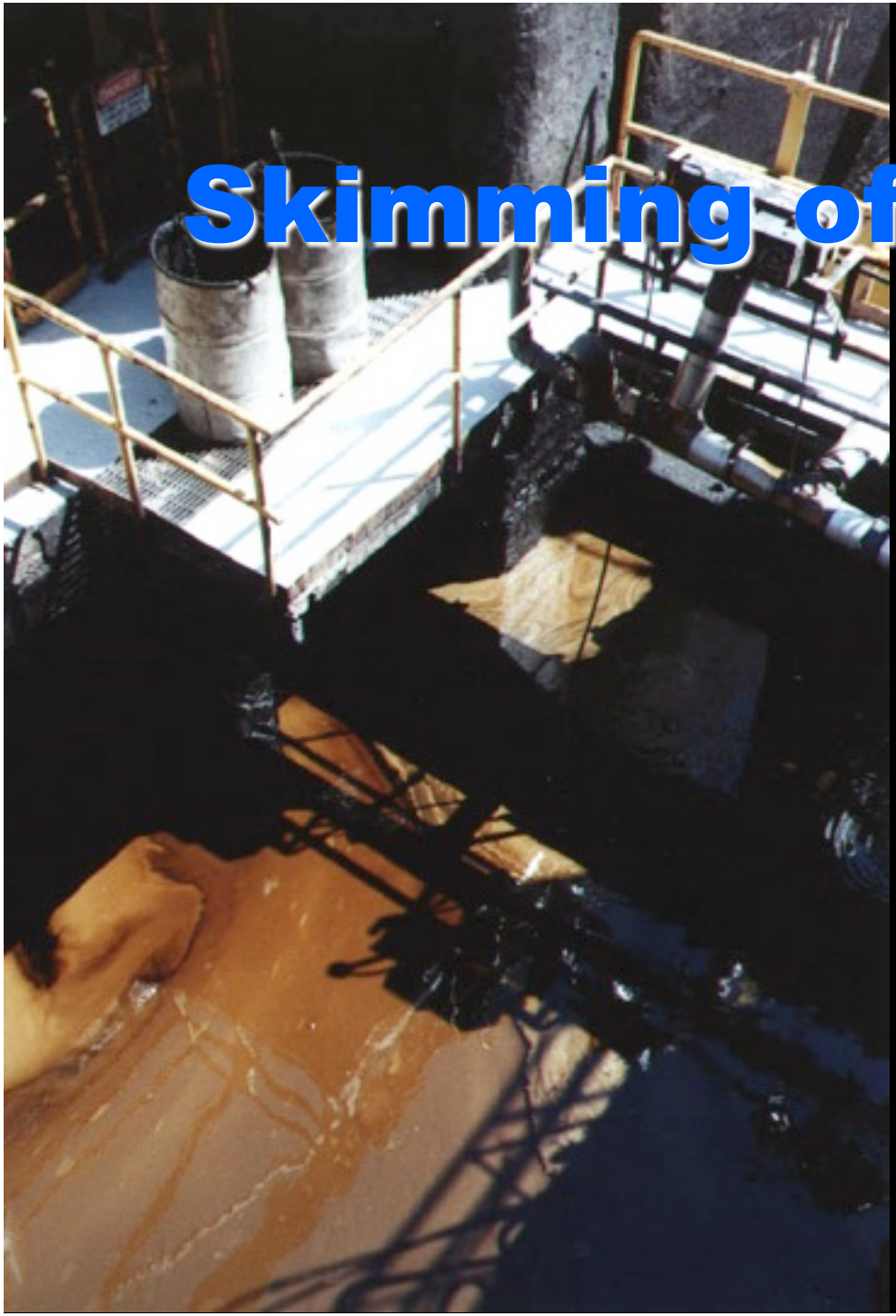
BOD	Carbonaceous	Nitrogenous
Copper	1.0	0.005
Nickel	1.0	0.25
Zinc	0.8	0.08
Cyanide	0.1	0.34
Arsenic	0.1	-
Phenols	200	4.0

Wet Weather Flow Storage



Industrial Waste Solids Removal

- Bar Racks 2” - Steel Bars
- Screens 0.5” SS Wire Mesh
- Comminutors 0.4” Slots



Skimming of Floatables

Greases:

- Fats
- Oils
- Wax

Influent Equalization

- Blending of Different Sources
- Flow Equalization
  - Daily, Seasonal Variations
  - Infiltration, Rainfall
- Waste Concentrations
  - Production Wastes vs. Cooling Waters
- Neutralization
  - Acids, Bases

Aerated Grit Chamber

Grit Settled for 60 minutes

Fine Sand > 0.2 mm,

Dense Organic Debris:

S.G. 1.3 to 2.7

Organic Matter Suspended at velocity > 1 foot / sec

Grit Collection
• Inclined Continuous Screw
• 1-4 cubic feet per million gallons

Acid Neutralization Process

Lime Storage (CaO)

Slaked Lime $Ca(OH)_2$

Mixing Basin

Lime Slurry Fed in Three Stages

Lime dissolution yields hydroxide, carbonate ions;

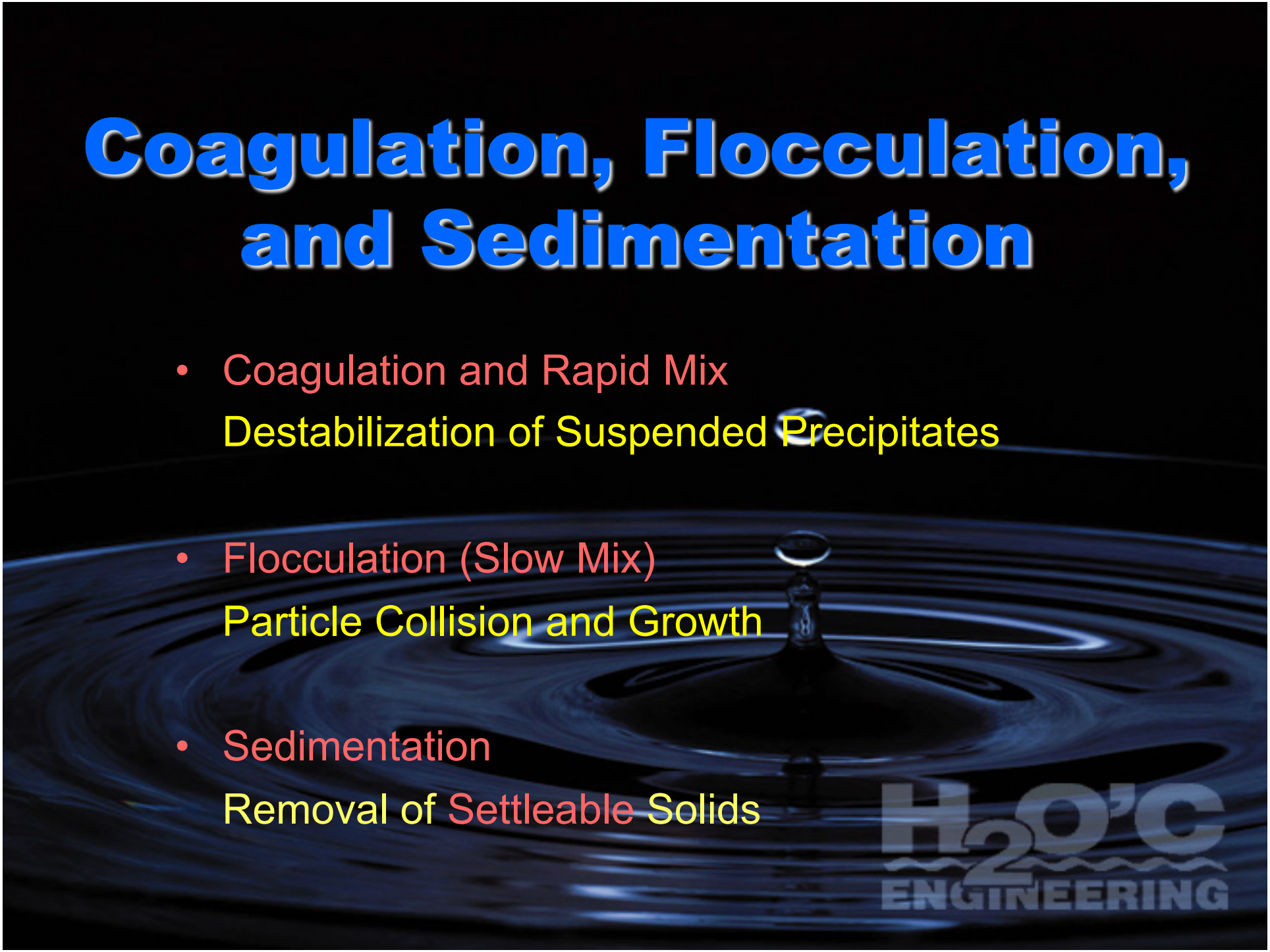
precipitates metal hydroxides,carbonates.

Neutralization Basin

Lime feed adjusted to maintain pH 8.3 in plant effluent

Coagulation, Flocculation, and Sedimentation

- Coagulation and Rapid Mix
  Destabilization of Suspended Precipitates
- Flocculation (Slow Mix)
  Particle Collision and Growth
- Sedimentation
  Removal of Settleable Solids



Solids Removal Process

Coagulation

Rapid Mix

Flocculation

Settling

Flumes

Flow diversion to two parallel treatment trains

Anionic polymer coagulant addition

Rapid mixing in flumes

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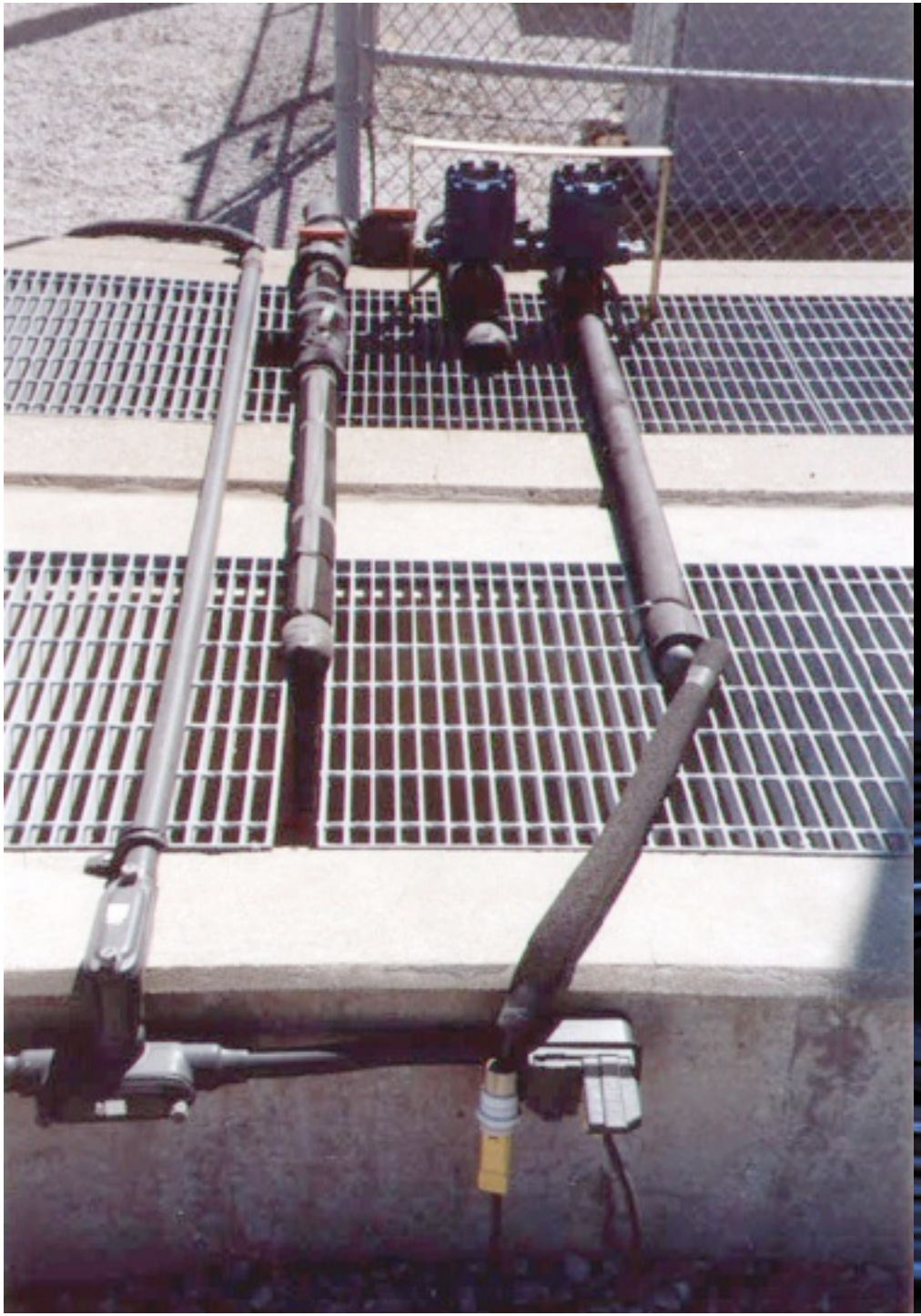

Polymeric Coagulant Feed

Polymer diluted to:

0.1 percent

(1,000 ppm)

Polymer Dose:

1 - 3 mg/l

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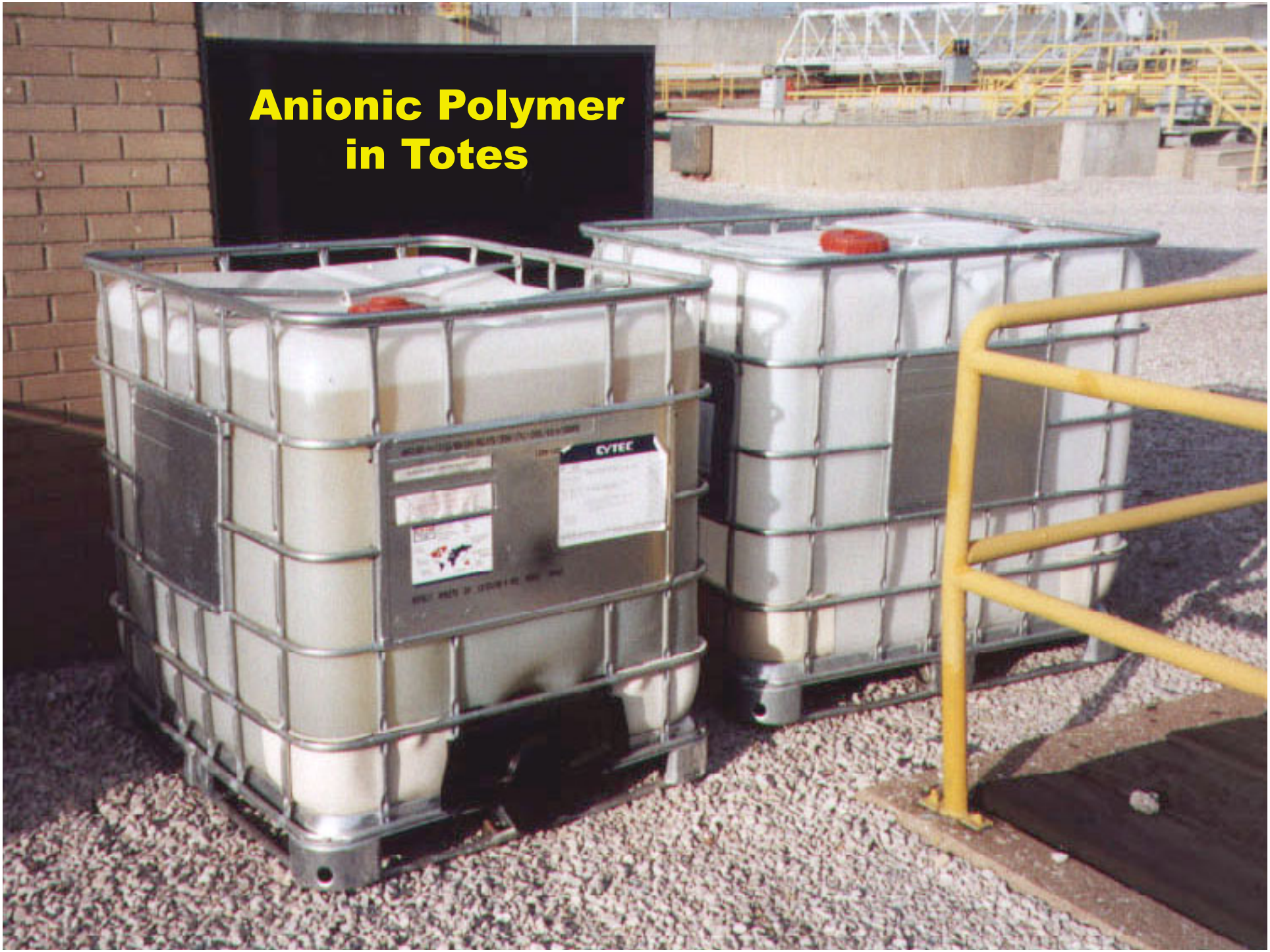

Anionic Polymer
in Totes
CYTEC

Synthetic Polyelectrolytes

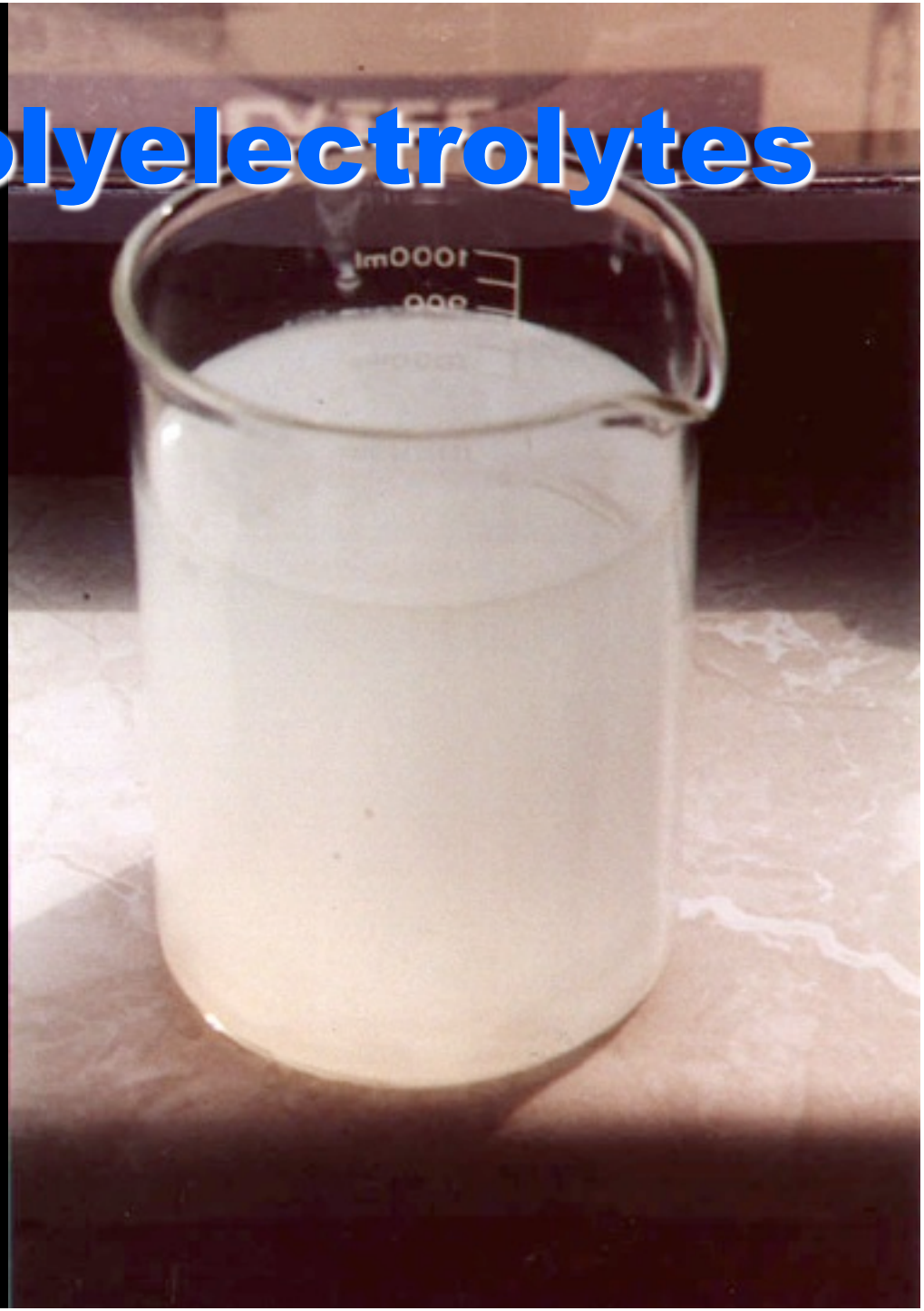
- Anionic (Negative)
- Cationic (Positive)
- Nonionic (Both)

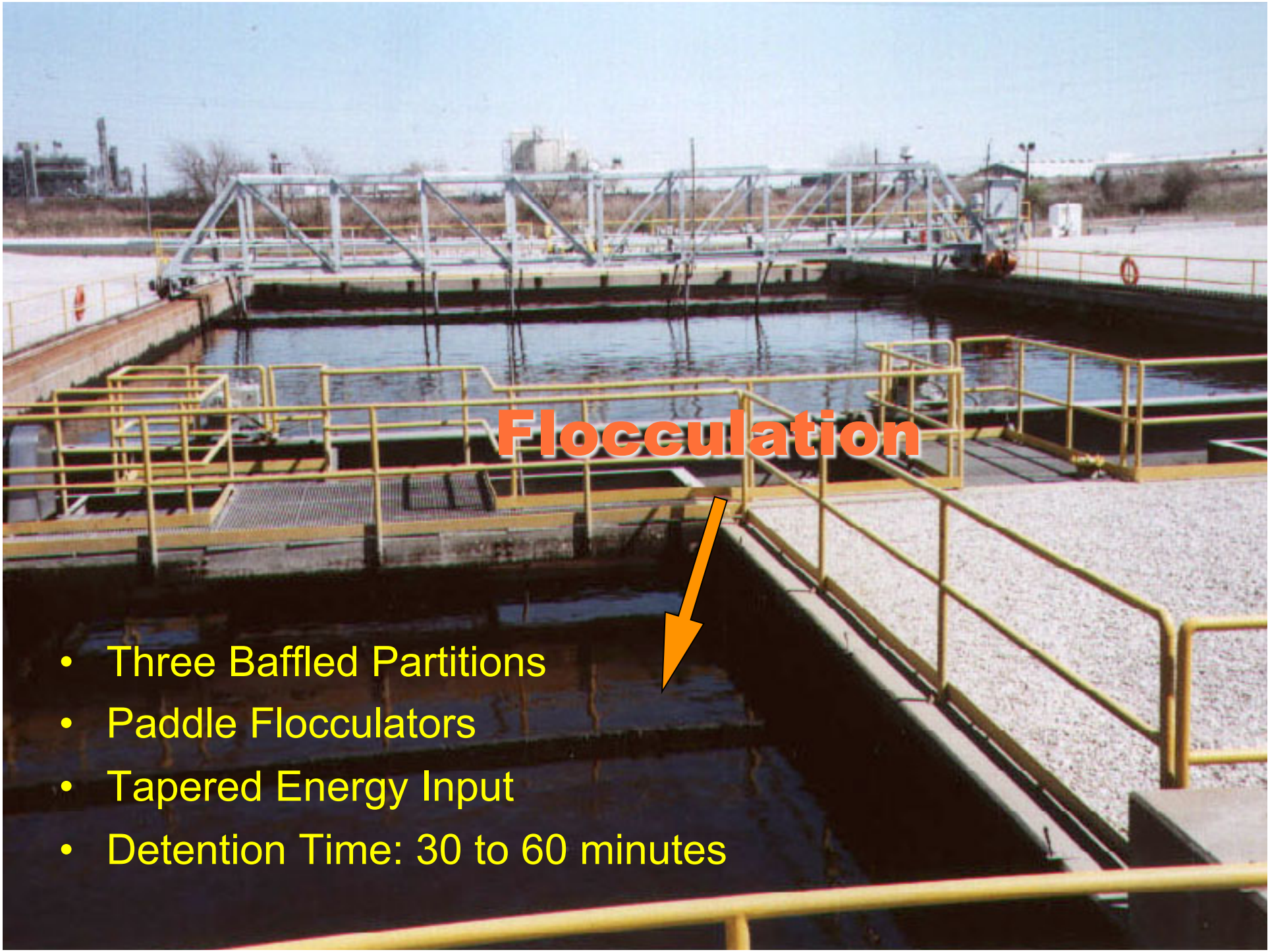
High Molecular Weight

~ 1,000,000 amu

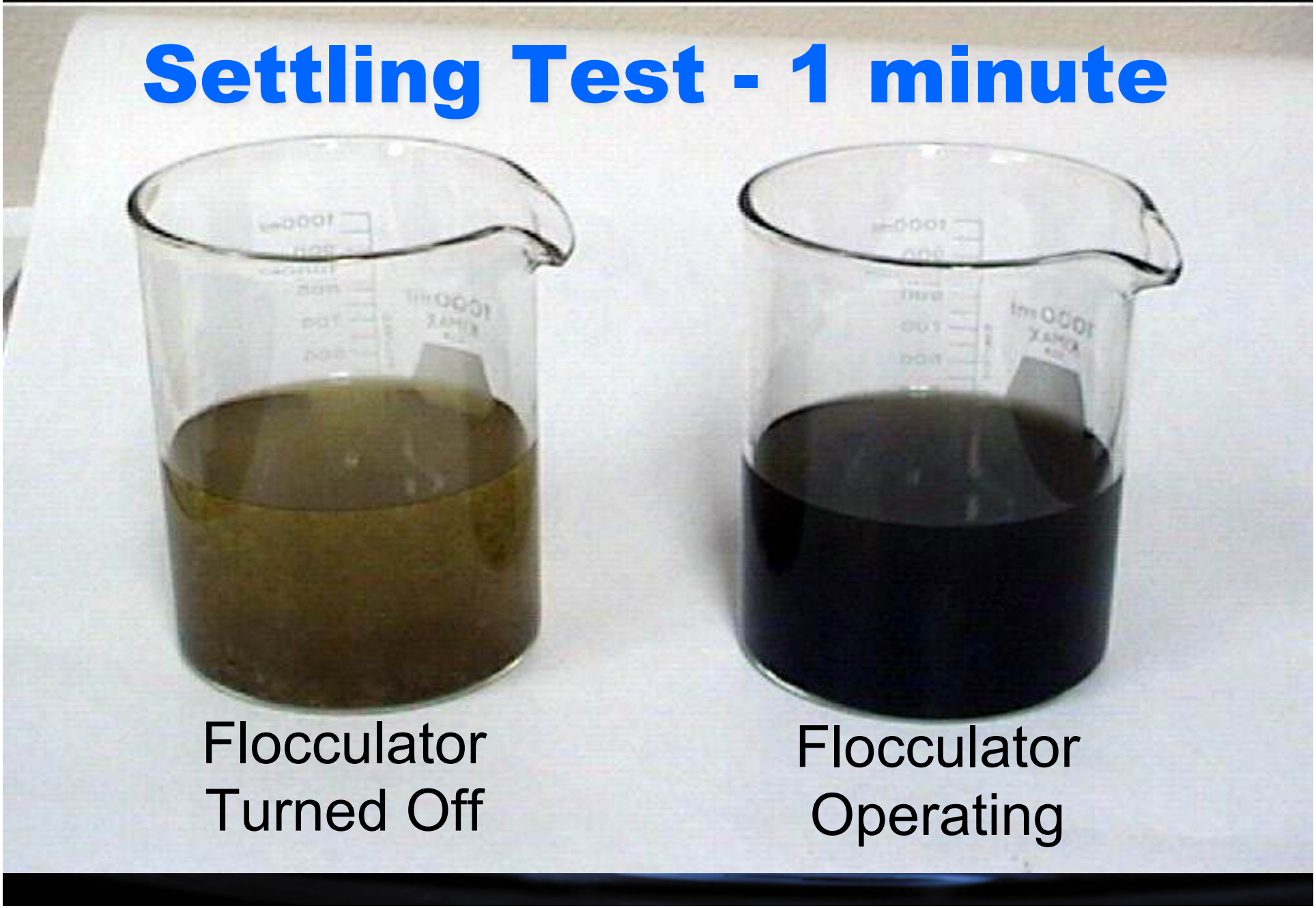
Dosage ≈ 1 mg/l

Interparticle Bridging




Flocculation
• Three Baffled Partitions
• Paddle Flocculators
• Tapered Energy Input
• Detention Time: 30 to 60 minutes

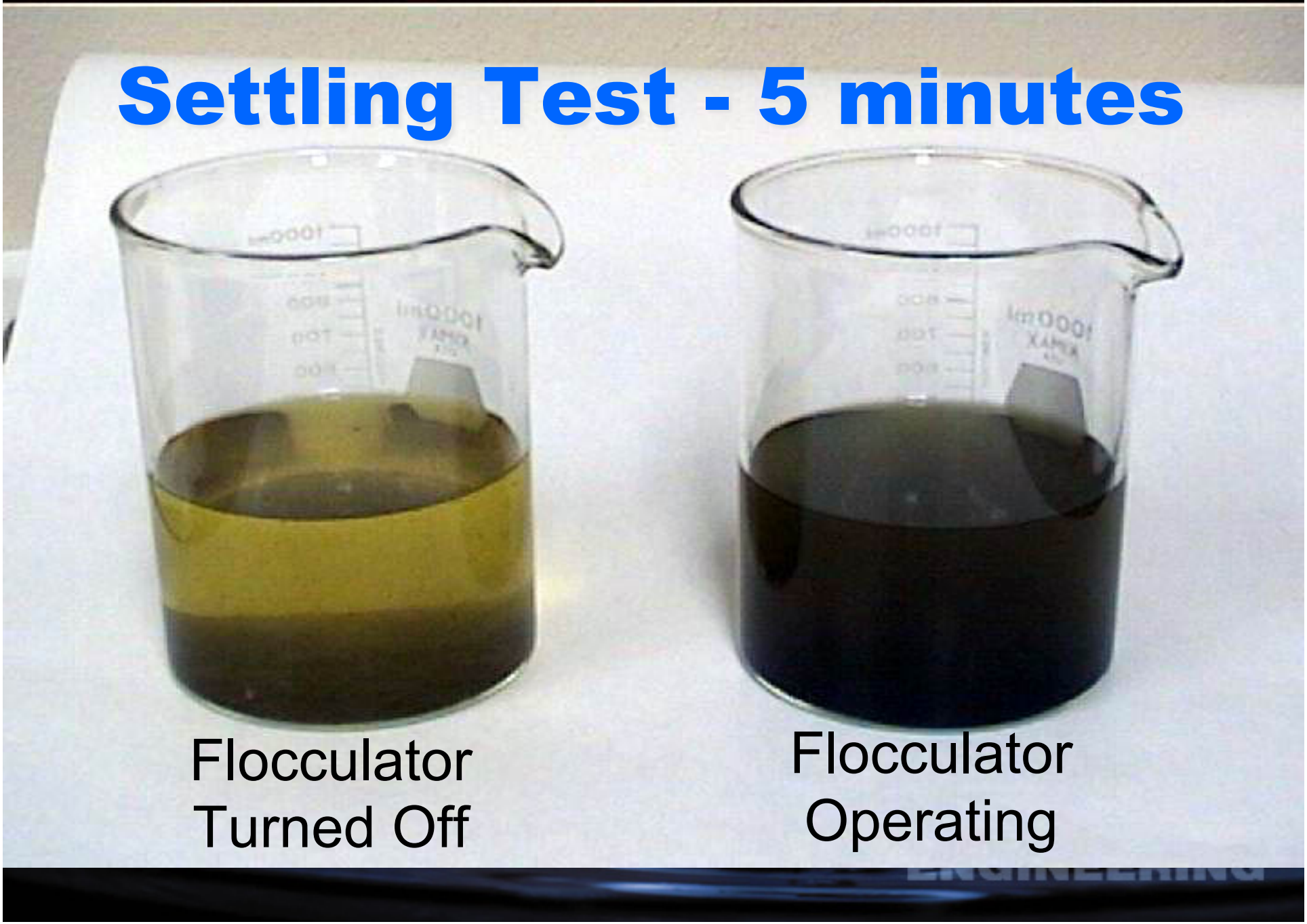
Settling Test - 1 minute



Flocculator
Turned Off

Flocculator
Operating

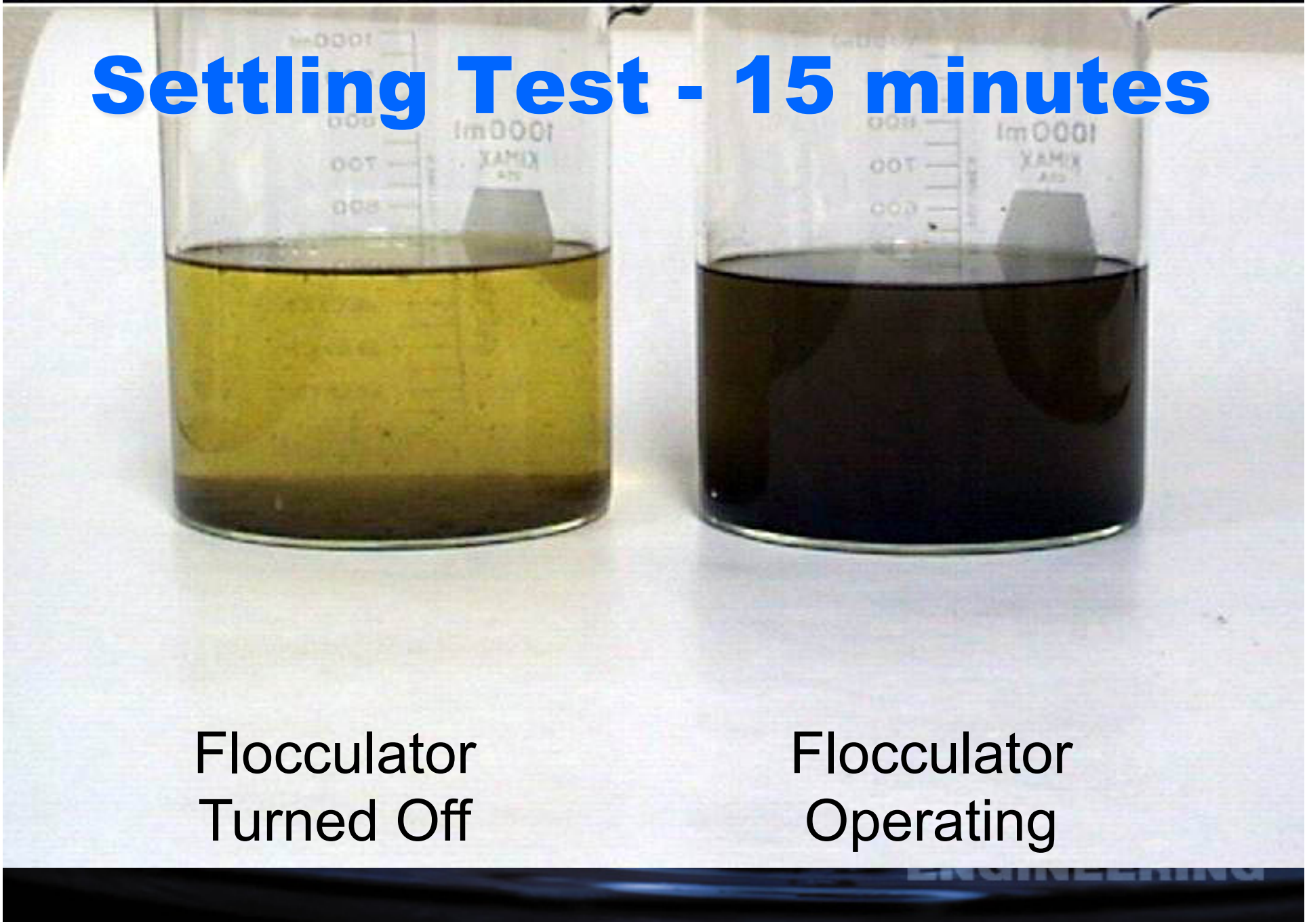
Settling Test - 5 minutes



Flocculator
Turned Off

Flocculator
Operating

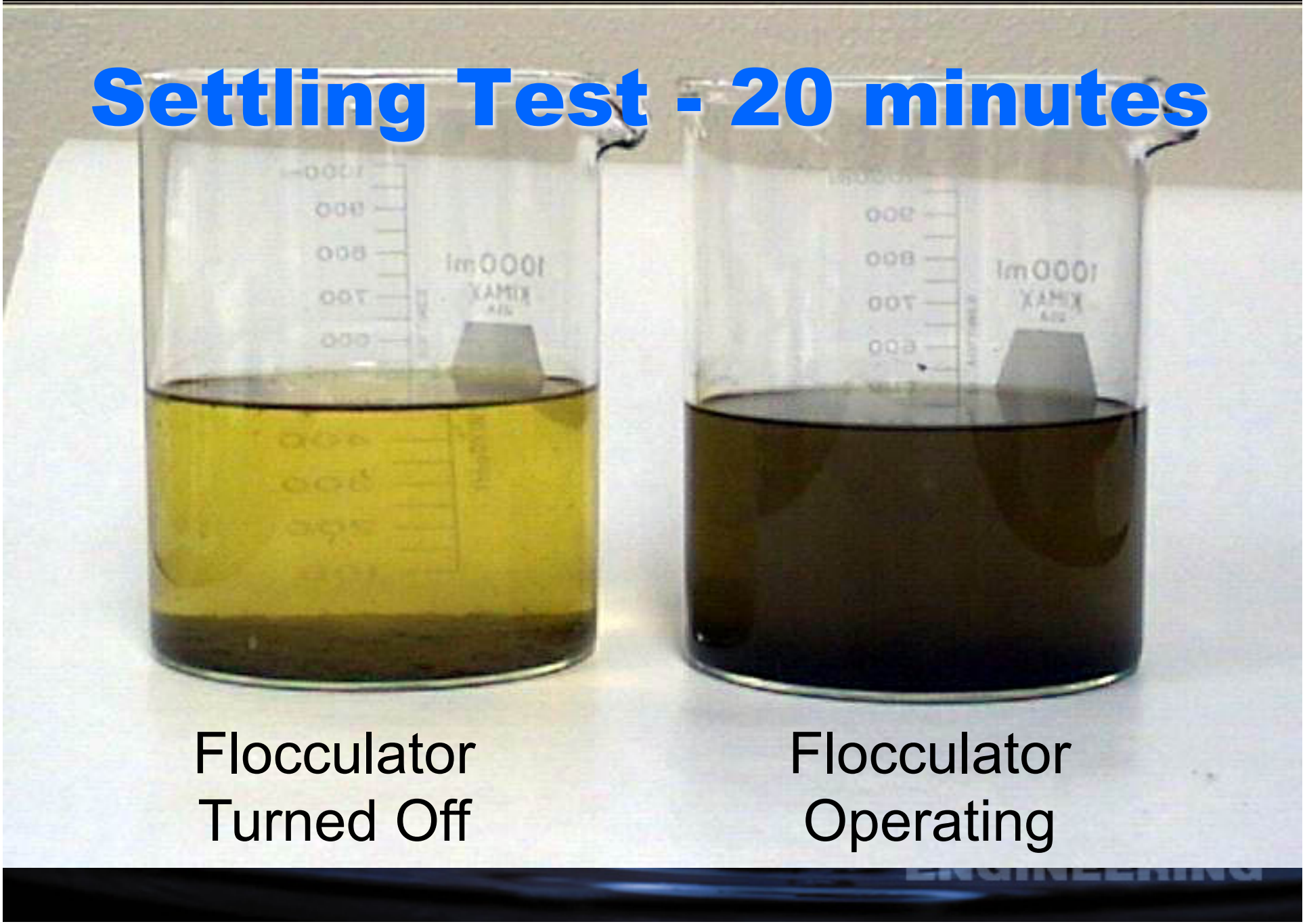
Settling Test - 15 minutes



Flocculator
Turned Off

Flocculator
Operating

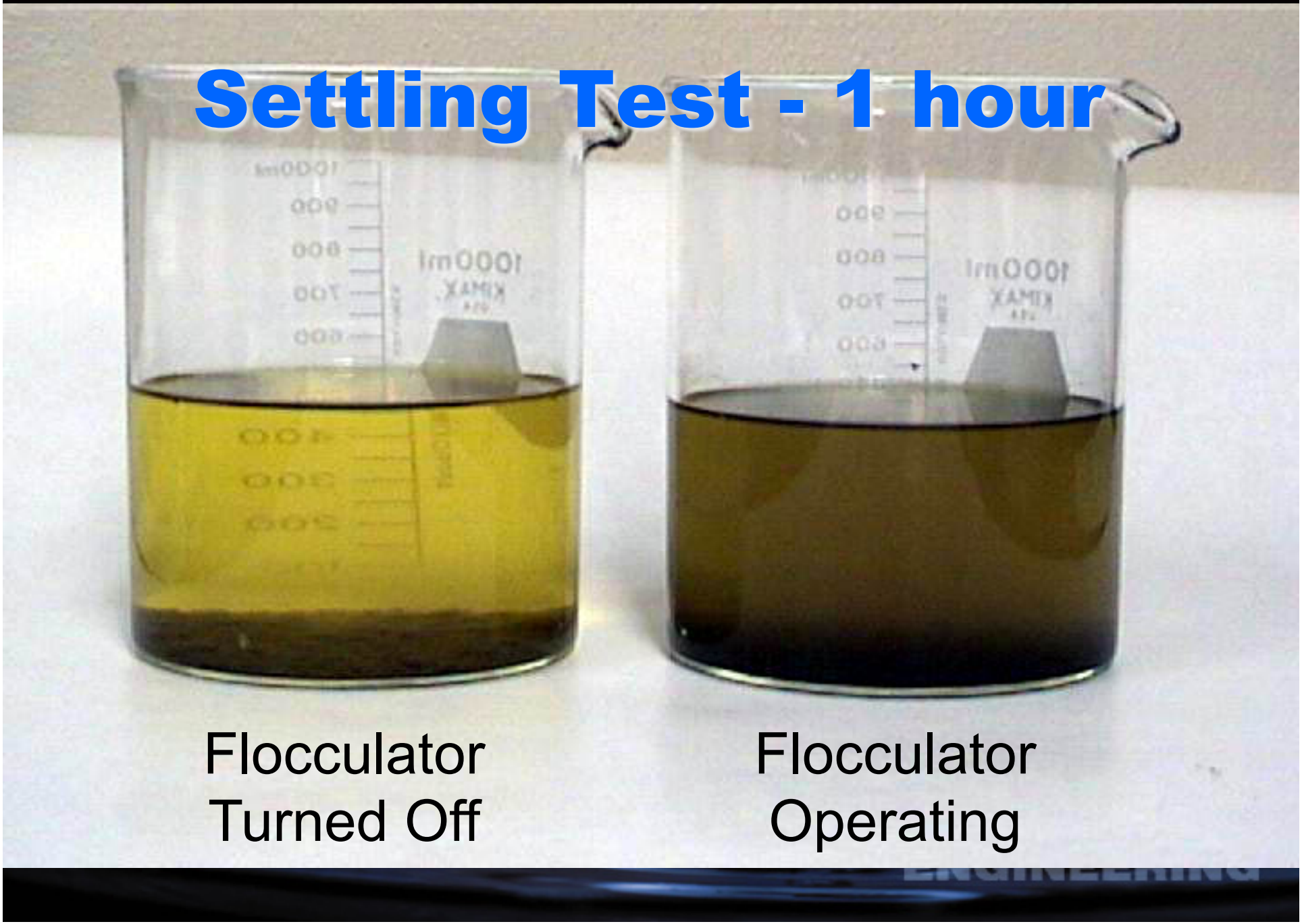
Settling Test - 20 minutes



Flocculator
Turned Off

Flocculator
Operating

Settling Test - 1 hour

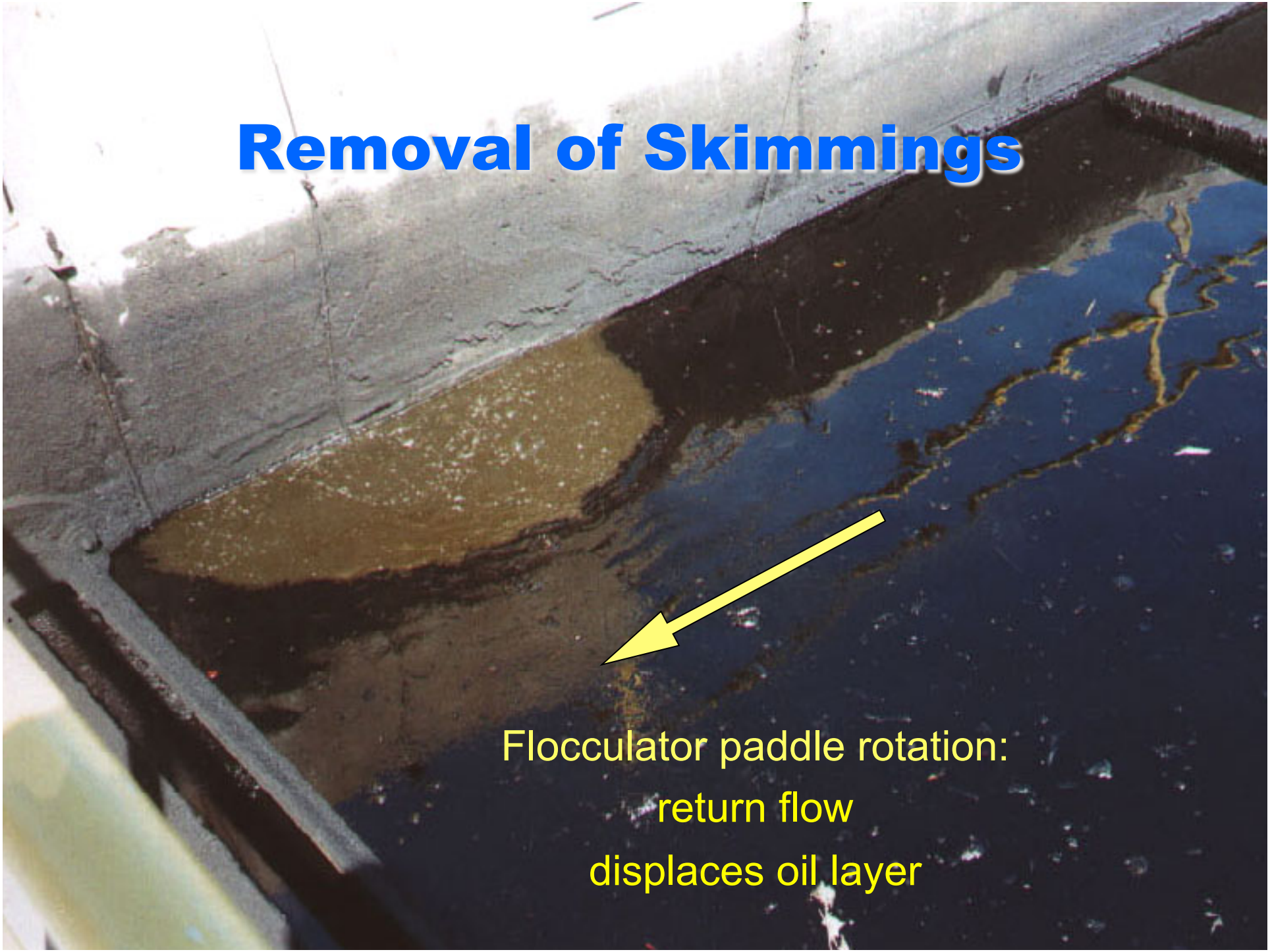


Flocculator
Turned Off

Flocculator
Operating

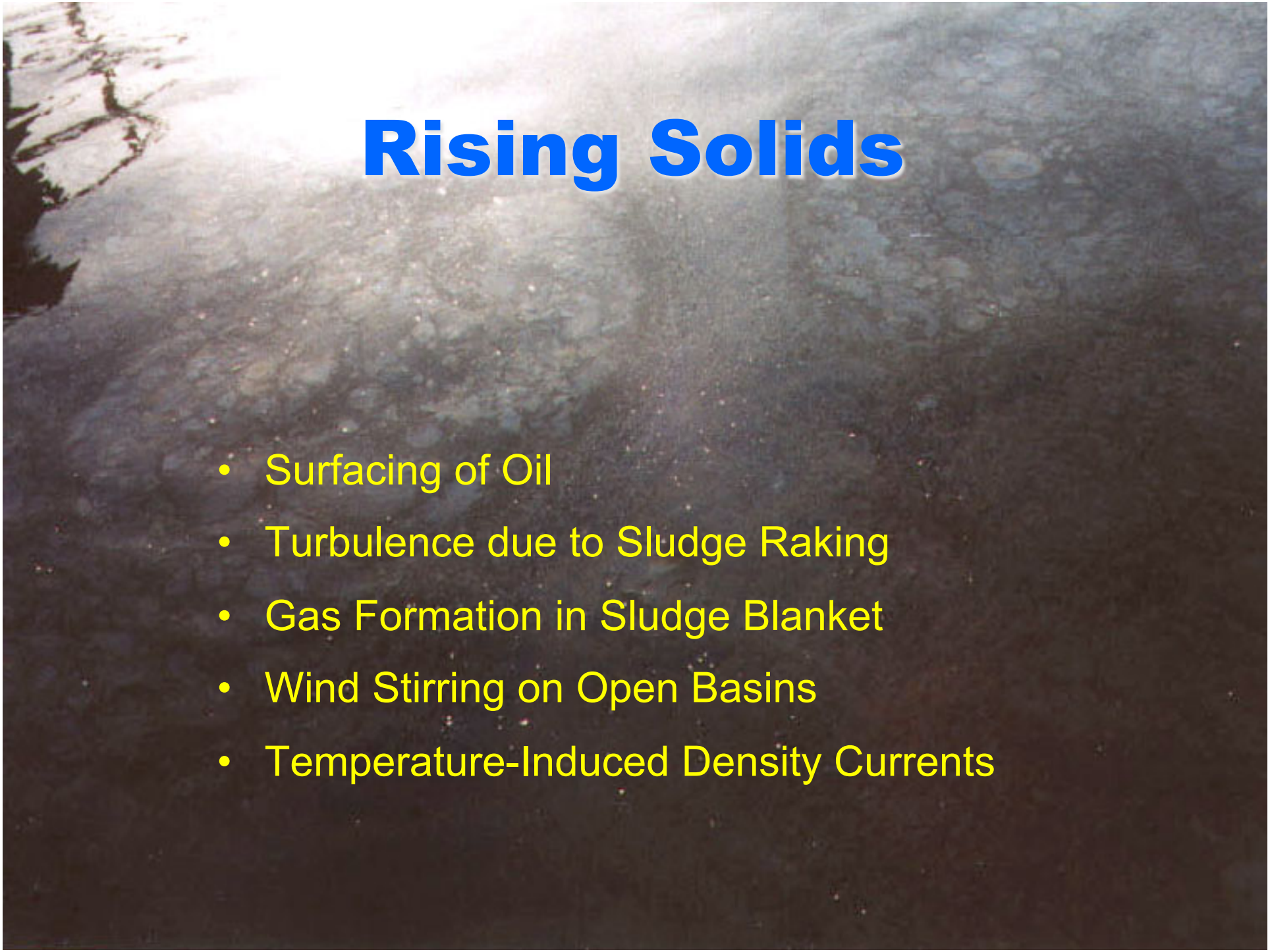
Removal of Skimmings

Removal of Skimmings



Settling Tanks

- Retention Time: > 2 hours
- Surface Loading Rate: < 1,000 gpd/sf
- Sludge Storage Hoppers
- Sludge Rake Mechanisms



Rising Solids

- Surfacing of Oil
- Turbulence due to Sludge Raking
- Gas Formation in Sludge Blanket
- Wind Stirring on Open Basins
- Temperature-Induced Density Currents

Sludge Removal Mechanism

Chain-Driven Flights

Continuous Raking

Intermittent Solids Removal

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Effluent Weirs

V-notch weirs
to minimize effect
of wind set-up and
turbulence

Serpentine launders
to ensure
overflow rate
< 20,000 gal/ft/day

Settling Tank Detention

Ideal Tank:

3 mgd flow in 0.9 mg tank: 0.3 days retention

Deviation from Ideal:

- Inlet, Outlet and Sludge Storage Zones
- Variations in Flow, Uneven Distribution
- Temperature (Density), Dead Spots
- Wind Stirring, Set Up, Seiches
- Turbulence, Sludge Blanket Upsets

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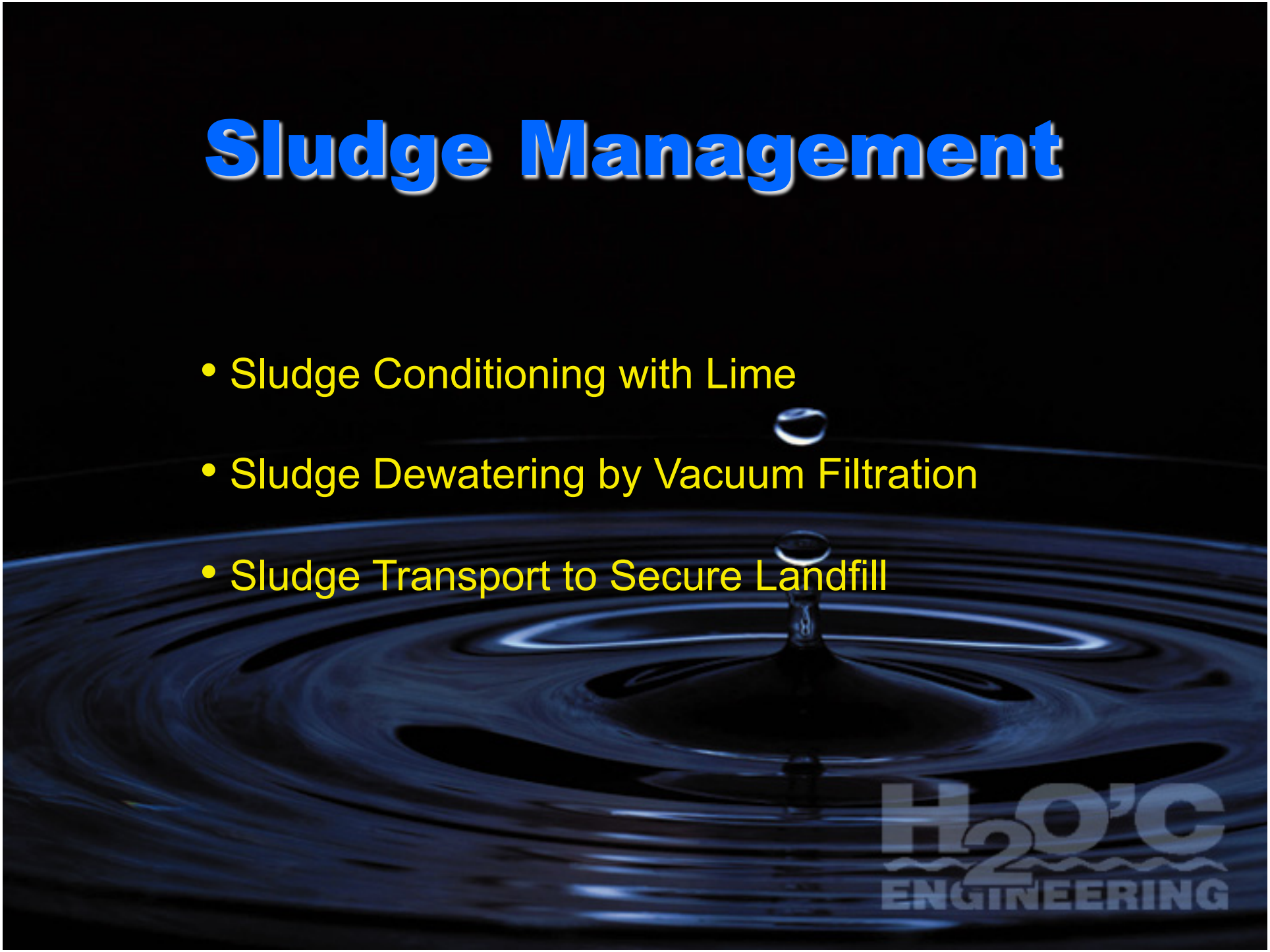
Sludge Management

- Sludge Conditioning with Lime
- Sludge Dewatering by Vacuum Filtration
- Sludge Transport to Secure Landfill



Sludge Thickening

Lime Feed:
1,300 lbs. per day

Influent Solids: 1.4 %

Effluent Solids: 9.0 %

Filtrate: pH 11

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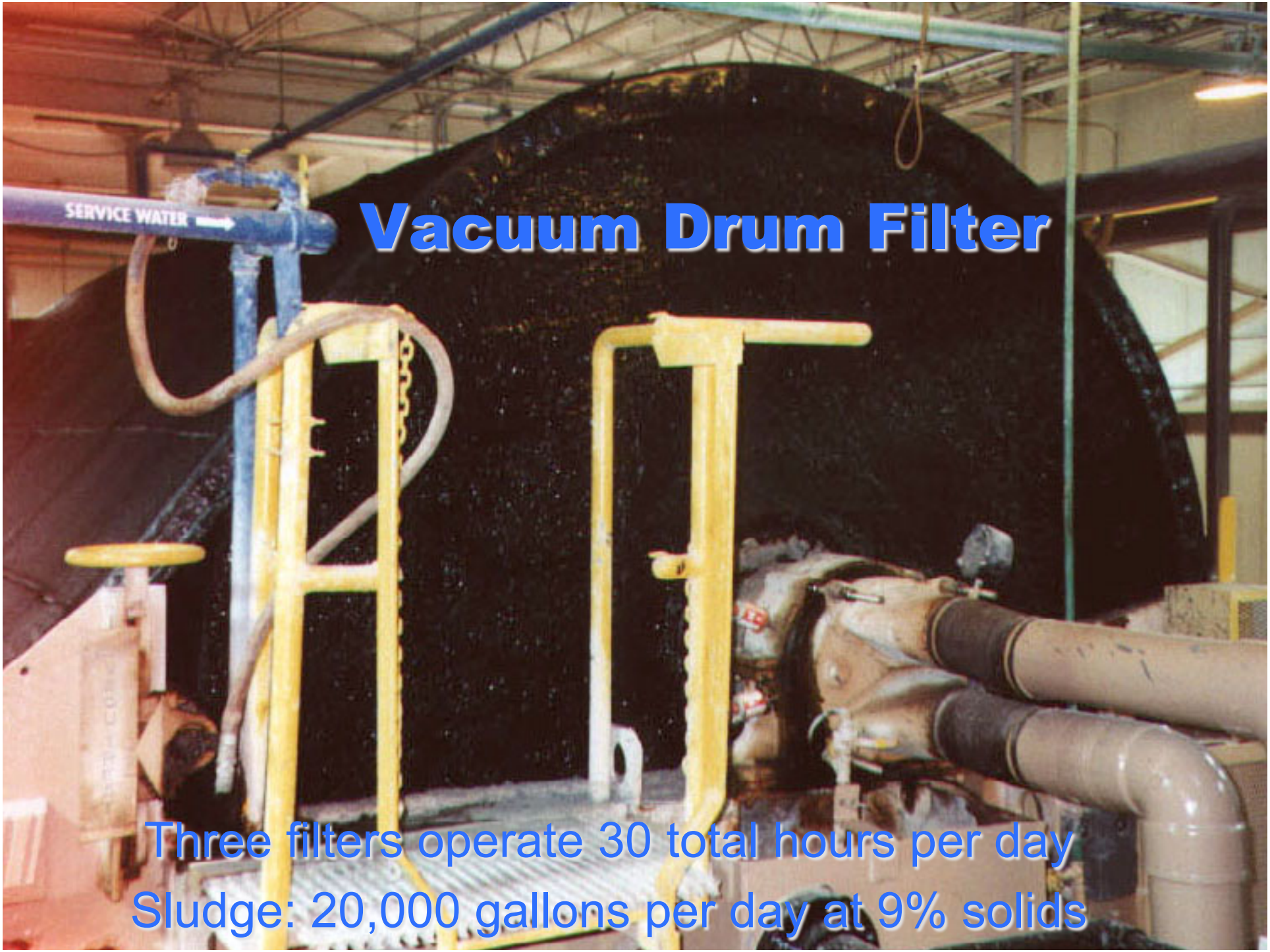


Vacuum Drum Filter

Three filters operate 30 total hours per day

Sludge: 20,000 gallons per day at 9% solids

Capillary Suction Time:
200 seconds (raw sludge)
10 seconds (conditioned)

Filter Cake

Filter Cake on Conveyer

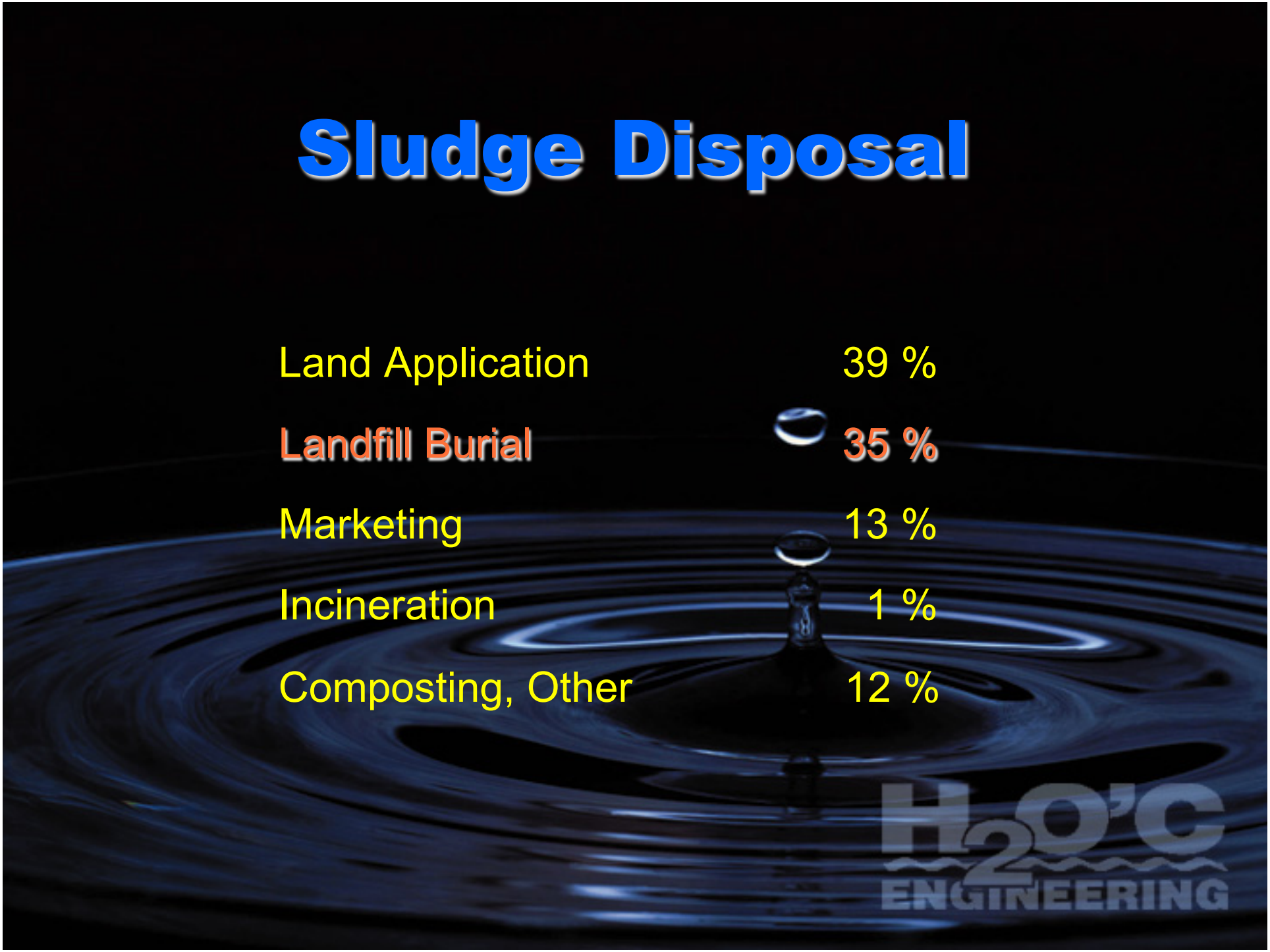
Solids increased from
9% to 27%

Three-fold sludge volume reduction

29 cu. yards/day

Sludge Disposal

Land Application	39 %
Landfill Burial	35 %
Marketing	13 %
Incineration	1 %
Composting, Other	12 %



Sludge Heavy Metals

Precipitated metals are recovered in sludges which are then unsuitable for disposal on land.

	Zn	Cu	Cd
		ppm, dry weight	
Dayton, OH	8,390	6,020	830
Monterey, CA	3,400	720	< 200
Cincinnati, OH	9,000	4,200	< 40

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Summary

Industrial Waste Pretreatment includes:

Screening; Skimming of Grease and Oil; Grit Removal

Equalization of Flow, Blending, Acid-Base Neutralization

Precipitation of Toxic Metals with alkalis (e.g., Lime)

Removal of Precipitated Metals requires:

Addition of Coagulant, Rapid Mix to disperse chemicals

Flocculation (slow mix) to form settleable floc, Sedimentation

Disposal of Metal-Bearing Sludges requires:

Sludge thickening for volume reduction, improved filterability

Transport of dewatered solids to secure landfill

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Chapter 4

What you can't (or shouldn't) put into your

Sanitary Sewer

Everyone knows that we shouldn't dry kittens in the microwave, but how many are aware of the many prohibitions communities have enacted to protect our sanitary sewerage systems and sewage treatment plant processes?

What can't (or shouldn't) we put in our toilets, sinks and household drains? Do most communities really prohibit us from emptying pool water or pumping out water from our flooded basements? Are there even ordinances against discharging *'stinky stuff'?*

After consulting the local regulations, we may be left wondering what we are permitted to put into our sanitary sewers.

Worse. In regions where treated wastewater is now destined to be an increasingly large part of our public water supply, prohibitions may get even more restrictive.

What you can't (or shouldn't) put into your

Sanitary Sewerage System

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Early Sewerage Systems

India, Pakistan: 3300-13000 BCE
China: City of Linzi

Rome Cloaca Maxima (Greatest Sewer), 600 BCE

presided over by the goddess, Cloacina.

Medieval Europe waterways functioned as sewers

street drains = 'kennels' (canals, channels)

Paris Brick-vaulted sewers, 1370

chamber pot contents prohibited

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U.S. Supreme Court:

Carson v. Brockton (Mass.) Sewerage Commission (1901)

Mandates, Taxes for Public Sewers?

Municipal Socialism?
Unconstitutional?

Restrictions on Discharges

Flammables

Any liquid, solid, or gas

gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers,

alcohols, ketones, aldehydes, peroxides and methyl ethyl ketone

which may create a fire or explosion hazard

or injure the sewerage system.

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Restrictions on Discharges

Solids

sand, mud, metal, glass, wood, paper, plastics, rags, rubber, latex, lime or other slurries, garbage, bones, hair, human parts, hides or fleshings, animal guts or tissues, feathers, ashes, cinders, stone or marble dust, straw, shavings, grass clippings, spent grains, spent hops, tar, asphalt residues, residues from refining or processing fuel or lubricating oil, grease, glass grinding or polishing wastes

capable of causing obstruction to the flow in sewers,
or interfering with the proper operation of the wastewater system.

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Restrictions on Discharges

Stinky Stuff

Noxious or malodorous liquids, gases or solids which prevent safe entry into sewers for purposes of inspection, maintenance or repair.

Malodor substance	Odor intensity		
	2.5	3	3.5
Ammonia	1	2	5
Methyl mercaptan	0.002	0.004	0.01
Hydrogen sulfide	0.02	0.06	0.2
Dimethyl sulfide	0.01	0.04	0.2
Dimethyl disulfide	0.009	0.03	0.1
Trimethylamine	0.005	0.02	0.07
Acetaldehyde	0.05	0.1	0.5
Styrene	0.4	0.8	2.0
Propionic acid	0.03	0.07	0.2
n-Butyric acid	0.001	0.002	0.006
n-Valeric acid	0.0009	0.002	0.004
i-Valeric acid	0.001	0.004	0.01
Toluene	10	30	60
Xylene	1	2	5
Ethyl acetate	3	7	20
Methyl isobutyl ketone	1	3	6
Isobutyl alcohol	0.9	4	20
Propionaldehyde	0.05	0.1	0.5
n-Butylaldehyde	0.009	0.03	0.08
Isobutylaldehyde	0.02	0.07	0.2
n-Varelaldehyde	0.009	0.02	0.05
Isovarelaldehyde	0.003	0.006	0.01

Restrictions on Discharges

Poisons & Pharmaceuticals

Mercury, polychlorinated biphenyls (PCBs), phenanthrene or pesticides:

dieldrin, chlordane, 1,1,1-Trichloro-2,2-bis(p-chlorophenyl)-ethane (4-4 DDT), demeton, endosulfan I, endosulfan II, endrin, guthion, heptachlor, malathion, methoxychlor, mirex, parathion, acrolein, aldrin, TDE, DDE, Hexachlorocyclohexane, lindane, benzene-cis-hexachloride and benzene-transhexachloride (BHC), hexachlorocyclopentadiene and toxaphene

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Restrictions on Discharges

Metals + Toxins

Metals

Antimony
Arsenic
Boron
Cadmium
Chromium
Copper
Lead
Nickel
Selenium
Silver
Zinc

Organics

Cyanide
Chlorinated Naphthalenes; Fluoranthene
Hexachlorobutadiene; Pentachlorophenol
Phenolic Compounds; 2 -chlorophenol
2 ,4-dichlorophenol; 2 ,4-dimethylphenol
4,6-dinitro-o-cresol; 2 ,4-dinitrophenol
2 -nitrophenol; 4-nitrophenol
p-chloro-m-cresol; 2 ,4,6-trichlorophenol

Total Toxic Organics
Trichloroethylene260

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Restrictions on Discharges

F-O-G

fats, oils, grease of vegetable or animal origin

which may solidify or become viscous.

Restaurants are commonly required to install and maintain grease traps.

Used Oil and Grease is scavenged for rendering into lard, tallow, soap, biodiesel.

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Restrictions on Discharges

Pathogens

disease-causing organisms

biological waste, hospital or medical wastes,

animal or veterinarian wastes

Restrictions on Discharges

Water

Swimming Pool Water

Storm Water

Ground Water

Dewatering Drainage

Subsurface Drainage

Tidewater

Accumulated Surface Water

Cooling Water

Industrial Process Waters

Foundation Water

Manhole Water

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Infiltration and Inflow (I & I)

Smoke Bomb Testing

Infiltration/Inflow causes dilution in sanitary sewers, decreasing the efficiency of wastewater treatment.

Smoke bombs are used to check sanitary sewers for illegal storm water connections & groundwater infiltration.

Restrictions on Discharges

Impairers of Treatment Capacity

Acids, Plating Solutions (neutralized or not)

Dyes (causing discoloration or turbidity)

Hot Liquids (temperatures >150° Fahrenheit)

Corrosive Liquids [pH < 5.5 (acidic) or > 10.5 (alkaline)]

Radioactive Wastes (Hospitals & Reactor Labs)

Strong Wastes (BOD > 400 mg/l; e.g., septage)

Hazardous Waste
(or wastewater which
has come in contact
with hazardous waste)

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Restrictions on Discharges

Bill Stuffers

Wastewater Utilities

campaign to stop dangerous, extraneous and untreatable substances from being discharged to sanitary sewers.

Even drain cleaner is cited as unsuitable for discharge to sewer drains.

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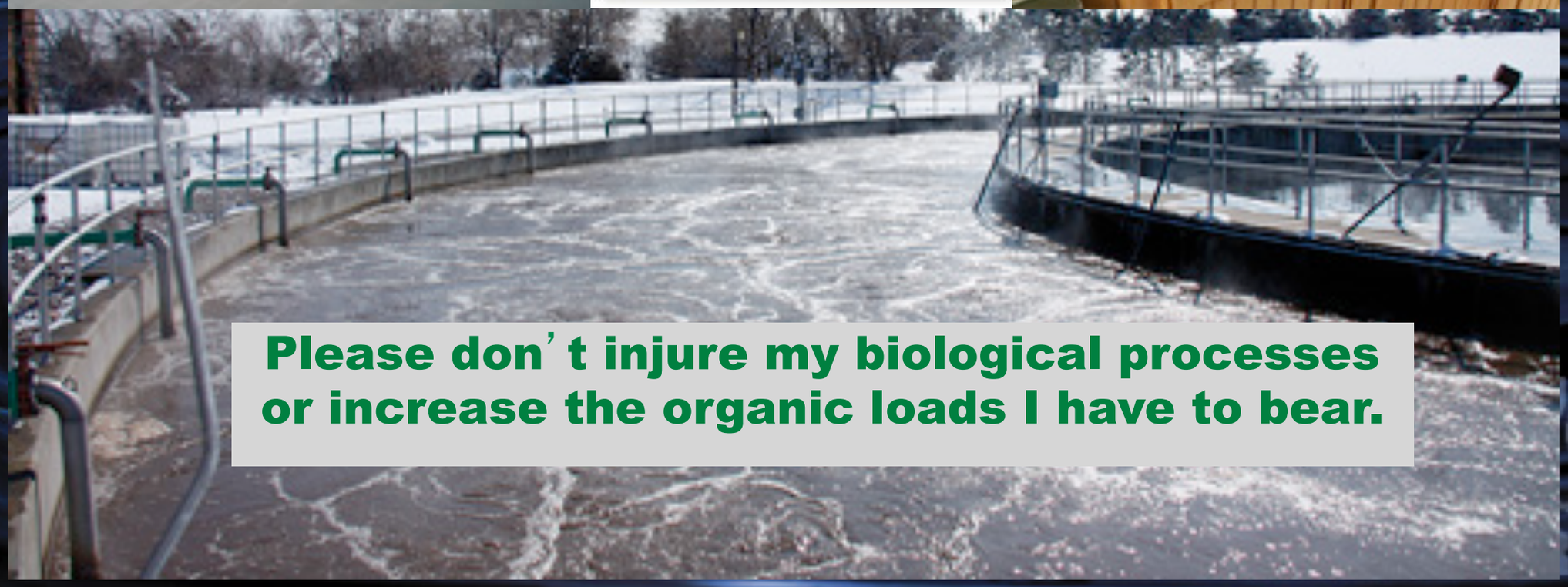
Restrictions on Discharges

What is Acceptable?



Please don't injure my biological processes or increase the organic loads I have to bear.

Household Water Use

Conservation

Water Utilities

urge consumers to fix leaks;

install flow restrictors on

showers and faucets;

purchase low-flow toilets;

flush less frequently, and

buy water-efficient washing machines

Troubled by Restrictions on Sewer Discharges ?

Think of it from my Point of View!

I work down the manhole
With a guy named Bruce.
And we are in charge
Of all the refuse.
He lets me go first
While he holds the lid.
I'm telling you, sheesh…
What a sweet kid.

My father he worked
In the sewer Uptown.
I followed his footsteps
And worked my way down.
That's how I began
In this here industry.
I just sort of fell into it.
Sheesh, lucky me.

I work in the sewer,
It's a very hard job.
You know they won't hire
Just any old slob.
You don't have to wear
A tie or a coat.
You just have to know
How to float.

A funny thing happened
To Bruce yesterday.
The tide came along
He got carried away.
He come out in Jersey.
But it' s O.K. now.
Cause that' s where
He lives anyhow.

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